Journal of Chemical Education

Published by

Division of Chemical Education of The American Chemical Society

Easton, Pa.

Entered as Second-class Matter, January 31, 1924, at the Post Office at Easton, Pa., under the act of March 3, 1859. Accepted for mailing, at special rate of postage provided for in Section 1103 Act of October 3, 1917, authorized January 31, 1924.

Copyright, 1930, by Division of Chemical Education, American Chemical Society

The Journal of Chemical Education is indexed in the Education Index and Industrial Arts Index

Vol. VII **June, 1930** **No. 6**

CONTENTS

	Page
Frontispiece	1224
Editor's Outlook	1225
The Dialyzer	1230
Adolf von Baeyer (1835–1917). Ferdinand Henrich	1231
My Student Days in Germany. *A Correction on Bunsen.* L. W. McCay	1248
Experimental Manipulation of Gases from Cylinders. Harold S. Booth	1249
Printing Processes. II. Surface or Planographic Processes. Saul B. Arenson	1263
The Peanut Industry. III. Peanut Products. D. F. J. Lynch	1277
Liquid Ammonia as a Solvent and the Ammonia System of Compounds. VI. Organic Ammonia Compounds. Part I. Introduction. The Ammono Alcohols. W. Conard Fernelius and Warren C. Johnson	1291
The Decolorizing Action of Carbon: A Demonstration. T. J. Otterbacher	1299
Dr. F. P. Venable's Contributions to Chemistry. James M. Bell	1300
Lectures and Lecture Experiments. A. W. Davison	1305
Twenty Years of Experimenting in Teaching College Chemistry. Herman Schlundt	1310
Training High-School Chemistry Students to Drill Themselves. Bruce F. Lamont	1315
A Beginning Course Based on the Principles of Chemistry. Ernest E. Bayles	1317
Association and Polymerization. S. T. Bowden	1322
Selling High-School Chemistry to the Community. R. C. Kistler	1324
The Organization of the High-School Science Club. Ralph E. Dunbar and Carrie Schafer	1327
A Method of Teaching Equation Writing. Charles H. Stone	1332
Memorials in Chemistry Laboratories. II. Priestley. Jesse E. Day	1334
Laboratory Experiments on the Boiling-Point Curves of Binary Mixtures. Frank J. Soday and George W. Bennett	1336
Visual Aids in Chemical Education. III	1341
The Atlanta Meeting. *Secretary's Report*	1349
Recitation or Laboratory First. *Committee Report*	1355
The Training of Teachers of Chemistry in Secondary Schools in Some Foreign Countries. *Committee Report*	1363
Professional Spirit among High-School Teachers of Chemistry. III. *Committee Report*	1366
Preliminary Announcement—Cincinnati Meeting, September 8–12, 1930	1371
The Chemistry Student:	
Some Elementary Principles of X-Ray Crystal Analysis. III. Otto Reinmuth	1373
Two Models for the Illustration of Industrial Processes. S. C. Dennis	1385
Chemistry for the Amateur Photographer. VI. Printing and Toning	1388
A Dance of Carbon Particles. Howard James	1400
Winners in Seventh "What Is Wrong?" Contest	1402
The Library	1404
Chemical Digest:	
The Growing Importance of Frequency	1410
Abstracts	1412

Apparatus, Laboratory Practice, and Demonstrations: An Improved Receiver for Vacuum Distillation. An Improved Calomel Electrode Vessel. An Improved Weight Buret. Multiple Melting-Point Apparatus. A Simple and Inexpensive Refractometer. Novel Filtration Aids. A Projection Model to Illustrate the Passage of an Alpha Particle in the Neighborhood of an Atomic Nucleus. A Model to Explain the Mechanism of Electrolysis. Anhydrous Magnesium Perchlorate as a Drying Agent. Microscopic Examination of Precipitates as an Aid to Precise Analysis. I. Estimation of Sulfates as Barium Sulfate. A Colorimetric Determination of Tin. The Quality of Commercial Ether. The Action of Gaseous Chlorine on Metallic Oxides and Silicates. Solution of Arsenous and Mercuric Iodide. Mercury. Thionyl Chloride. Modern Methods of Producing High Vacuum and Various Phenomena of Electronic Emission in High Vacuum. **Teaching Objectives, Methods, and Suggestions:** A Chemistry Study Outline. Experiment in Education: An Adventure. An Experiment in Teaching. Selling Physics and Chemistry. Poster Projects. Suggested Programs for a Science Club. First Experiments with Talkies in American Schools. A Microcinematographic Apparatus for the Owner of a 16-Mm. Motion Picture Camera. **Keeping Up with Chem-**

istry: Health in the Chemical Industry. The Relation of the Chemical Industry to Pharmacy. Chemical Industries of the South. 1929 Artificial Silk Production Estimated at Over 400 Million Pounds. Paper Making. Cellulose in the Light of the X-Rays. Paints. Is Smoke Responsible for Property Damage? The Facts about Industrial Alcohol. The Quality of Commercial Ether. Preservation of Fats. Progress of Organic Chemistry, 1924–28. II. The Identification of Pigments Used in Painting at Different Periods, with a Brief Account of Other Methods of Examining Pictures. Gypsum as a Construction Chemical. Production and Liquefaction of Some Industrial Gases. Gum, Tannin, and Resin in Relation to Specificity, Environment, and Function. Dependence of Aviation on Metallurgy. Colloidal Metals as Therapeutic Agents. Thyrite: A New Material for Lightning Arresters. Concerning Wire. Ferro-Alloys as Factors in Steel Production. Protective Coating for Iron and Steel. Recent Developments in Corrosion and Heat-Resisting Steels. Prevention of Corrosion of Lead in Buildings. Antimony. Calcium. Iron. Potassium: Its Radioactivity: Its Isotopes: and Its Association with the Phenomena of Life. Silver. Occurrence of Germanium and Arsenic in Meteorites. Earth Colors. Ocher. Sienna. Umber. Ferric Oxide. Iodine. Rubber Age Resisters. Uses of Rubber Latex. Rubber in Airplane Construction. Accelerators of Vulcanization and Their Uses. Termite Control. Chemical Warfare. Why We Need Minerals in the Diet. Soil and Sod. The Relation of Media pH to the Bacteriostatic Action of Dyes. The Modern Sun Cult. Ultra-Violet Light. **Scientific Reviews and Bibliographies:** Mercury. Organic Compounds of Mercury and Their Properties. Thionyl Chloride in Organic Chemistry. Valence. Accelerators of Vulcanization and Their Uses. Soil and Sod. **Historical and Biographical:** Wallach, Otto. Ostwald, Friedrich Wilhelm. Boerhaave. Faraday, August Kekulé and His Importance in the Chemical Industry. Lavoisier, Founder of Modern Chemistry. Pasteur. My Personal Reminiscences of Pasteur. Paul Duden on the Occasion of His 25th Year of Service with the I. G. Farbenindustrie A.-G. Adolf Lehne. Dr. Theodor Plieniger. Dr. I. Rosenberg on the Occasion of His 70th Birthday on February 6, 1930. J. J. van Laar. Free Radicles Two Centuries Ago. History of Mexico's Richest Silver Mines. **Educational Measurements and Data:** Objective Tests. Measured Outcomes of Laboratory Instruction. Do Students Who Study Chemistry in High School Elect That Subject in College? **The Philosophy of Education:** Education for a Better World. Economic Effects of Education. Does High-School Chemistry Serve the Proper Purpose? Educating Tomorrow's Citizens. Circuses or Colleges. **Professional:** Training Secondary School Teachers in Universities. The Training of Science Teachers, Here and Abroad. The Training of Ph.D.'s. **Contemporary News and Comments in Chemistry and Education:** Preliminary Report of the Committee on Education of the American Institute of Chemists. Proposed Studies in Chemical Education. The George Herbert Jones Laboratory. Roozeboom Medal. Progressive Chemistry. The Journal of Chemical Education. **Foreign Chemical and Educational Conditions:** The Training of Science Teachers, Here and Abroad. **General:** Dr. Herbert Levinstein on "Chemical Disarmament." Importance of Chemical Research. Some Recent Changes in Our Attitude toward the Physical World. Cancer as a Public Health Problem. The Organic World and the Causal Principle. Organic Evolution: Its Problems and Perplexities. Melioration by Matter. Water for Chicago's Growing Populace.

Local Activities 1428
Recent Books 1447
An Index to Book Reviews in 1929. Leopold Scheflan 1454

NOTICE TO AUTHORS OF PAPERS

1. Forwarding Address. Papers intended for publication in THIS JOURNAL should be submitted to Neil E. Gordon, Editor, The Johns Hopkins University, Baltimore, Maryland.

2. Manuscript. The manuscript submitted should be an original (not a carbon) copy, and typewritten, double-spaced, with 2–3 cm. margins. The title of the article should be followed by the name and address of the author. If the paper has been presented at a meeting, a footnote giving name of society, date, and occasion should immediately follow the author's name. The usual editorial customs, as exemplified in the most recent issues of the JOURNAL, should be followed as closely as possible.

3. References and Footnotes. Each reference to the literature and each footnote should be inserted without a number, as a separate line (or lines) immediately following the word to which it refers in the text. A reference to literature should include, in the order named, the title of book or article, author's name, edition or volume, pages, date of publication, and, in the case of books, publisher's name.

4. Illustrations. Not all articles lend themselves to illustrations, but articles which do should be accompanied by as many pertinent illustrations as possible. As a rule, apparatus, particularly if complicated, is best presented by means of line or working drawings. Photographs are sometimes sufficient, however. When both can be obtained, it is generally desirable to include both.

Photographs should have a gloss finish and should be at least post-card size—larger, if possible. Only prints which are unblurred and which show sharp contrast between light and dark areas can be satisfactorily reproduced.

Line drawings should be carefully prepared in black ink on plain white drawing paper or blue drawing cloth, twice or three times the size desired in the printed cut; it is convenient, when permitted by the scale required, to have them the size of the manuscript. When coördinate paper is used, it should be printed in blue only, with the important coördinate lines ruled over in black; the black square should in general not be less than ten millimeters on a side; the lines of the curves should be the heaviest, except the frame; points on the curves should be indicated by true circles, not crosses. The numbering of the coördinate axes, the number of the figure and any necessary explanations of the figure should be written in pencil in the margin of the sheet, as they are usually set up in type rather than reproduced from the drawing. All lines, numbers, and letters that are to be reproduced are to be so proportioned that they will be clearly legible in the cut.

Tables should be inserted in the body of the manuscript at the proper place.

All photographs, line drawings, and tables should be provided with self-explanatory titles or legends. Each illustration should be marked in pencil on the margin with the name of the author and the title of the article to which it refers.

DIVISION OF CHEMICAL EDUCATION OF THE A. C. S.

OFFICERS

Chairman: JOHN N. SWAN, University of Mississippi, University, Miss.
Vice-Chairman: MARTIN V. MCGILL, Lakewood High School, Lakewood, Ohio.
Secretary: ROSS A. BAKER, Syracuse University, Syracuse, New York.
Treasurer: ROSALIE M. PARR, University of Illinois, Urbana, Illinois.
Editor-in-Chief: NEIL E. GORDON, The Johns Hopkins University, Homewood, Baltimore, Maryland.

COMMITTEES

Executive Committee: JOHN N. SWAN, University of Mississippi, University, Mississippi, *Chairman;* M. V. MCGILL, *Vice-Chairman;* R. A. BAKER, *Secretary;* ROSALIE M. PARR, *Treasurer;* B. S. HOPKINS, WILLIAM MCPHERSON, and WILHELM SEGERBLOM, *Past Chairmen;* NEIL E. GORDON, *Editor-in-Chief.*

Aids to Visual Instruction in Chemistry (Estd. 1926): M. V. MCGILL, Lakewood High School, Lakewood, Ohio, *Chairman;* L. A. ASTELL, CLARENCE E. BAER, I. L. NIXON, R. C. RUNKLE.

Chemical Education of the Non-Collegiate Type (Estd. 1928): R. E. BOWMAN, Wilmington Trade School, Wilmington, Delaware, *Chairman;* HERMAN A. ERNST, ARTHUR GUILLAUDEU, MORRIS LAWRENCE, ALLEN ROGERS, R. E. ROSE.

Chemical Education by Radio (Estd. 1930): ROBERT F. MCCRACKAN, Medical College of Virginia, Richmond, Virginia, *Chairman;* S. B. ARENSON, OTTO J. SIEPLEIN.

Chemistry Clubs (Estd. 1930): G. D. BEAL, Mellon Institute, Pittsburgh, Pennsylvania, *Chairman;* ROBERT COLLIER, JR., J. J. CONDON, ESTHER A. ENGLE, J. A. RIDDICK.

Chemistry Libraries (Estd. 1930): RUFUS REED, Montclair, New Jersey, *Chairman;* W. A. NOYES, LORNE LEA.

Correlation of High-School and College Chemistry (Estd. 1929): NEIL E. GORDON, The Johns Hopkins University, Homewood, Baltimore, Maryland, *Chairman;* LOUIS W MATTERN, LYMAN C. NEWELL, WILHELM SEGERBLOM.

Labels (Estd. 1929): JOHN M. MICHENER, Wichita High School East, Wichita, Kansas, *Chairman;* L. R. LITTLETON, W. O. WALKER.

Major Topic Organization of High-School Chemistry (Estd. 1928): H. A. CARPENTER, West High School, Rochester, New York, *Chairman;* V. J. CHAMBERS, B. C. HENDRICKS, J. H. JENSEN, GRETCHEN KAUFMAN, H. R. SMITH.

Minimum Equipment for High-School Chemistry (Estd. 1926): J. H. JENSEN, Northern State Teachers' College, Aberdeen, South Dakota, *Chairman;* W. G. BOWERS, F. C. MABEE, J. H. NORTON, C. R. OTTO, C. H. STONE.

Naming and Scope of Committees (Estd. 1927): WILHELM SEGERBLOM, Phillips Exeter Academy, Exeter, New Hampshire, *Chairman;* A. J. CURRIER, J. C. HESSLER, L. R. LITTLETON, G. H. WHITEFORD.

Order of Presentation of Recitation and Laboratory Work (Estd. 1928): FRANK M. GREENLAW, Rogers High School, Newport, Rhode Island, *Chairman;* M. C. COLLISTER, O. E. MADISON, ROSALIE M. PARR.

Organic Nomenclature (*Joint Committee with Organic Division*) (Estd. 1930): C. D. HURD, Evanston, Illinois, *Chairman;* W. L. EVANS, F. B. DAINS, E. EMMETT REID, H. T. CLARKE, AUSTIN M. PATTERSON, JAMES F. NORRIS.

Preparation of High-School Chemistry Teachers (Estd. 1928): A. J. CURRIER, Pennsylvania State College, State College, Pennsylvania, *Chairman;* HENRIETTA HAYDEN, LOUIS W. MATTERN.

Research Problems (Estd. 1923): W. H. CHAPIN, Oberlin College, Oberlin, Ohio, *Chairman.*

Teacher Exchange (Estd. 1930): B. S. HOPKINS, University of Illinois, Urbana, Illinois, *Chairman;* F. B. DAINS, J. SAMUEL GUY, J. PEARCE MITCHELL.

Women's Club Study Course in Chemistry (Estd. 1924): HARRISON HALE, University of Arkansas, Fayetteville, *Chairman;* W. F. KEOHAN, CLARA DE MILT.

SENATE OF CHEMICAL EDUCATION

Alabama: J. R. SAMPEY, Howard Coll., Birmingham; A. S. BENHAM, Paul Hayne H. S., Birmingham; J. T. MACKENZIE, 4300 Glenwood Ave., Birmingham.

Arizona: L. E. ROBERTS, U. of Arizona, Tucson; ARTHUR L. PHELPS, Phoenix Jun. Coll., Phoenix; F. G. HAWLEY, Internatl. Smelting Co., Box 351, Miami.

California: *Sacramento*, J. H. NORTON, Sacramento Jun. Coll., Sacramento; ASA L. CAULKINS, High School, Stockton; JOHN C. BRISTOW, State Dept. of Agri., Sacramento; *San Francisco*, LIONEL DUSCHAK, 412 Hobart Bldg., San Francisco; *Southern California*, J. E. BELL, Calif. Inst. of Tech., Pasadena; ISABELLE WILSON, 3222 W. 60th St., Los Angeles; F. S. PRATT, Pacific R. & H. Chem. Corp., El Monte, Los Angeles Co.

Colorado: G. H. WHITEFORD, Colo. Agri. Coll., Ft. Collins; ROBT. COLLIER, Southside H. S., Denver; A. R. NEES, Great Western Sugar Co., 21st and Blake Sts., Denver.

Connecticut: G. ALBERT HILL, Wesleyan U., Middletown; STANLEY H. ROOD, 134 N. Beacon St., Hartford; ELBERT M. SHELTON, Cheney Bros., Manchester.

Delaware: ALBERT S. EASTMAN, U. of Delaware, Newark; ALLEN N. ZECHIEL, Tower H. S., Wilmington; HOLGER V. BERG, The Krebs Pigment & Chem. Co., Newport.

District of Columbia: REV. GEO. L. COYLE, S. J., Georgetown U., Washington; HENRY P. WARD, Catholic U., Washington; ALLEN J. MARSH, McKinley H. S., Washington.

Florida: V. T. JACKSON, U. of Florida, Gainesville; FRANCES WEST, 2001 Beach Drive South, St. Petersburg; C. F. SPEH, 1521 Barnette Natl. Bk. Bldg., Jacksonville.

Georgia: J. S. GUY, Emory U., Atlanta; T. W. CLIFT, Technical H. S., Atlanta; L. B. LOCKHART, Law & Co., Inc., Atlanta.

Illinois: *University of Illinois*, JOHN C. HESSLER, Knox Coll., Galesburg; H. W. GARNETT, 205½ North St., Normal; L. F. NICKELL, Monsanto Chem. Co., E. St. Louis; *Chicago*, H. R. SMITH, Lake View H. S., Chicago; DAVID KLEIN, Wilson Laboratories, Chicago.

Indiana: M. G. MELLON, Purdue U., Lafayette; FRANK B. WADE, Shortridge H. S., Indianapolis; H. W. RHODEHAMEL, Eli Lilly Co., Indianapolis.

Iowa: *Ames*, WINFRED F. COOVER, Iowa State Coll., Ames; FRANK E. GOODELL, 10th and Locust Sts., Des Moines; DALE L. MAFFITT, 10th and Locust Sts., Des Moines; *Iowa*, EDWARD BARTOW, State U. of Iowa, Iowa City; NEIL LUTES, 1595 Atlantic St., Dubuque; H. J. BROWNLEE, The Quaker Oats Co., Cedar Rapids.

Kansas: *Manhattan*, H. W. BRUBAKER, Kansas State Agri. Coll., Manhattan; E. B. KEITH, Kansas State Agri. Coll., Manhattan; W. F. BROWN, Kansas State Agri. Coll., Manhattan. *Wichita*, W. A. FLETCHER, Wichita U., Wichita; JOHN M. MICHENER, Wichita H. S., East, Wichita; D. EMERY COLWELL, Kansas State Protein Laboratories, Wichita.

Kentucky: J. S. PIERCE, Georgetown Coll., Georgetown; MARIE BORRIES, Girls' H. S., Louisville; H. A. SNYDER, Kentucky Color & Chem. Co., Louisville.

Louisiana: H. W. MOSELEY, Tulane U. of Louisiana, New Orleans; WALTER G. ALLEE, Newman Manual Training School, New Orleans; FRANK W. LIEPSNER, 420 Camp St., New Orleans.

Maine: C. A. BRAUTLECHT, U. of Maine, Orono; J. F. KOLOUCH, Mapleton H. S., Mapleton; E. SUTERMEISTER, S. D. Warren Co., Cumberland Mills.

Maryland: E. E. REID, Johns Hopkins University, Baltimore; FITZGERALD DUNNING, Hynson, Westcott & Dunning, Charles and Chase Sts., Baltimore.

Massachusetts: J. S. CHAMBERLAIN, Mass. Agri. Coll., Amherst; LAURA P. PATTEN, Medford H. S., Medford; G. J. ESSELEN, 276 Stuart St., Boston.

Michigan: O. E. MADISON, Coll. of City of Detroit, Detroit; A. C. STITT, Ann Arbor H. S., Ann Arbor; GEORGE WALKER, 9601 American Ave., Detroit.

Minnesota: W. M. SANDSTROM, U. of Minnesota, Minneapolis; F. H. SCHULTZ, Minnehaha Academy, Minneapolis; W. F. HOFFMAN, N. W. Paper Co., Cloquet.

Mississippi: A. E. WOOD, Mississippi Coll., Clinton; C. O. HINTON, Perkinston; C. A. LAMBERT, Hercules Powder Co., Hattiesburg.

Missouri: *Kansas City*, PERRY Y. JACKSON, Park Coll., Parkville; CARL F. GUSTAFSON, 109 W. 61st St., Kansas City; L. C. HOWE, Cudahy Packing Co., Kansas City; *St. Louis*, L. MCMASTER, Washington U., St. Louis; W. R. TEETERS, 5458 Clemens Ave., St. Louis; GEO. S. ROBINS, 511 S. 2nd St., St. Louis; *University of Missouri*, MARY V. DOVER, U. of Missouri, Columbia; OTIS M. WEIGLE, Westminster Coll., Fulton; K. K. KERSHNER, Rolla.

Montana: A. E. KOENIG, State School of Mines, Butte; DON C. EVANS, Park Co. H. S., Livingston; GLENN WILES, State Board of Health, Helena.

Nebraska: B. C. HENDRICKS, U. of Nebraska, Lincoln; J. J. GUENTHER, Omaha Technical H. S., Omaha; L. B. PARSONS, Cudahy Packing Co., Omaha.

Nevada: GEO. W. SEARS, U. of Nevada, Reno; E. C. STRENG, 766 W. St., Reno; C. W. DAVIS, Bureau of Mines, Reno.

New Hampshire: HERMAN C. FOGG, U. of New Hampshire, Durham; WILHELM SEGERBLOM, Phillips Exeter Academy, Exeter; G. A. RICHTER, Brown Co., Berlin.

New Jersey: WM. FOSTER, Princeton U., Princeton; R. B. WHITMOYER, Senior H. S., Atlantic City; JOHN B. FOSTER, Roseville Ave. and Orange St., Newark.

New Mexico: J. D. CLARK, U. of New Mexico, Albuquerque; C. W. BOTKIN, Box 95, State Coll.; JOHN H. GRIFFITH, State Teachers' Coll., Silver City.

New York: *Eastern New York*, CHARLES B. HURD, Union Coll., Schenectady; KATHARINE WEAVER, Emma Willard School, Troy; E. R. BAINBRIDGE, Duriron Co., 160 S. Manning Blvd., Albany; *New York City*, C. CARPENTER, Columbia U., New York; GEO. H. BRUCE, Horace Mann School for Boys, New York; H. L. FISHER, U. S. Rubber Co., Passaic, N. J.; *Rochester*, MARION LOUGEE, Keuka Coll., Keuka Park; H. A. CARPENTER, West H. S., Rochester; ERLE M. BILLINGS, 343 State St., Rochester; *Syracuse*, R. A. BAKER, Syracuse U., Syracuse; LUCY E.

LATHAM, Sherrill H. S., Sherrill; WASHINGTON PLATT, The Borden Co., Syracuse; *Western New York*, M. K. BUCKLEY, U. of Buffalo, Buffalo; VAN L. BOHNSON, du Pont Rayon Co., Sta. B, Buffalo.

North Carolina: L. F. WILLIAMS, State Coll. of Agri., Raleigh; J. O. HALVERSON, Dept. of Agri., Raleigh.

North Dakota: G. A. ABBOTT, U. of North Dakota, Grand Forks; DELOS HARGRAVE, Grand Forks H. S., Grand Forks.

Ohio: W. H. CHAPIN, Oberlin Coll., Oberlin; VERNON S. CULP, West H. S., Akron; W. E. GANGLOFF, 27 Parkwood Place, Cincinnati.

Oklahoma: H. M. TRIMBLE, Okla. A. & M. Coll., Stillwater; CLIFF R. OTTO, Central Teachers' Coll., Edmond; CLAUDE L. JOHNSON, Marland Lab., Ponca City.

Oregon: R. K. STRONG, Reed Coll., Portland; W. V. GREEN, Washington H. S., Portland; PERRY CRAWFORD, Calif. Oregon Power Co., Medford.

Pennsylvania: *Central Pennsylvania*, A. J. CURRIER, Pennsylvania State Coll., State College; L. PAUL MILLER, Central H. S., Scranton; *Erie*, R. E. LEE, Allegheny Coll., Meadville; W. E. COON, East H. S., Erie; M. A. KRIMMEL, Hammermill Paper Co., Erie; *Lehigh Valley*, J. SCOTT LONG, Lehigh U., Bethlehem; E. F. MARSIGLIO, 230 Porter St., Easton; *Philadelphia*, OWEN L. SHINN, U. of Pennsylvania, Philadelphia; WM. B. MELDRUM, Haverford Coll., Haverford; ROBT. H. BRADBURY, South Philadelphia H. S., Philadelphia; *Pittsburgh*, T. R. ALEXANDER, JR., Carnegie Inst. of Tech., Pittsburgh; E. R. CARSON, South Hills H. S., Ruth St., Pittsburgh; J. C. WHETZEL, American Sheet and Tin Plate Co., 210 Semple St., Oakland Sta., Pittsburgh.

Rhode Island: NORRIS W. RAKESTRAW, Brown U., Providence; FRANK M. GREENLAW, Rogers H. S., Newport; A. H. FISKE, Rumford Chem. Works, Providence.

South Carolina: J. E. COPENHAVER, U. of South Carolina, Columbia; LOUISE A. AGNEW, Due West Woman's Coll., Due West; C. D. BLACKWELDER, Box 226, Greenville.

South Dakota: J. H. JENSEN, Northern Normal and Ind. School, Aberdeen; ROBERT O. DOTT, Pierre; GUY FRARY, State Chem. Lab., Vermilion.

Texas: *Central Texas*, F. W. HOGAN, Texas Christian Univ., Fort Worth; W. A. CLARK, JR., Plemons; F. B. PORTER, Fort Worth.

Utah: C. E. MAW, Brigham Young U., Provo; T. B. BRIGHTON, U. of Utah, Salt Lake City; ALPHA JOHNSON, Utah Copper Co., Garfield.

Vermont: P. C. VOTER, Middlebury Coll., Middlebury; L. O. JOHNSON, Rutland H. S., Rutland; OTTO WINESTOCK, Perkinsville.

Virginia: GARNETT RYLAND, University of Richmond, Richmond; LEROY L. SUTHERLAND, Staunton Military Academy, Staunton; WILLIAM CLIFT, Richmond.

Washington: GRETCHEN KAUFMAN, R. 2, Box 299, Bellingham; F. A. RANTZ, R. 6, Box 277, Seattle; ZAHLIA J. GAILEY, Crescent Mfg. Co., Seattle.

West Virginia: F. E. CLARK, U. of West Virginia, Morgantown; W. A. MUDGE, Internatl. Nickel Co., Huntington.

Wisconsin: J. H. MATTHEWS, U. of Wisconsin, Madison; M. J. W. PHILLIPS, West Allis H. S., West Allis; HENRY B. MERRILL, A. F. Gallun & Sons, Milwaukee.

LOCAL ORGANIZATIONS THROUGH WHICH CHEMICAL EDUCATION IS FUNCTIONING

ALABAMA: **Alabama Section of the A. C. S.:** GEO. J. FERTIG, *Chairman;* C. S. WHITLET, *Secretary,* 3600 11th St., Birmingham.

ARIZONA: **Arizona Section of the A. C. S.:** J. D. SULLIVAN, *Chairman;* ROSALIND KLASS, *Secretary,* 834 E. Helen Street, Tucson.

ARKANSAS: **Arkansas Section of the A. C. S.:** HARRISON HALE, *Chairman;* LYMAN E. PORTER, *Secretary,* University of Arkansas, Fayetteville.

CALIFORNIA: **California Section of the A. C. S.:** C. G. MAIER, *Chairman;* L. ROSENSTEIN, *Secretary,* 1112 Market Street, San Francisco.

Sacramento Section of the A. C. S.: R. A. STEVENSON, *Chairman;* R. P. TUCKER, *Secretary,* Capitol Extension Building, Sacramento.

Southern California Section of the A. C. S.: CHARLES J. ROBINSON, *Chairman,* MARK WALKER, *Secretary,* 1984 Oak Street, South Pasadena.

COLORADO: **Colorado Section of the A. C. S.:** A. R. NEES, *Chairman;* L. W. HARTKEMEIER, *Secretary,* 817 Fifteenth Street, Golden.

CONNECTICUT: (*See* **New England States**).

DELAWARE: **Delaware Section of the A. C. S.:** A. W. KENNEY, *Chairman;* A. L. FOX, *Secretary,* P. O. Box No. 525, Wilmington.

DISTRICT OF COLUMBIA: District of Columbia Section of the A. C. S.: JOSEPH A. MULDOON, *Chairman;* ELMER KREHBIEL, *Secretary,* McKinley High School, Washington.

FLORIDA: **Florida Section of the A. C. S.:** R. S. BLY, *Chairman;* R. C. GOODWIN, *Secretary,* University of Florida, Gainesville.

GEORGIA: **Georgia Section of the A. C. S.:** ANDREW M. FAIRLIE, *Chairman;* W. P. HEATH, *Secretary,* Coca Cola Company, Atlanta.

ILLINOIS: **Chicago Section of the A. C. S.:** W. V. EVANS, *Chairman;* W. M. HINMAN, *Secretary,* Box 803, Chicago.

Illinois Association of Chemistry Teachers: W. E. HARNISH, *Chairman;* S. ALETA MCEVOY, *Secretary,* High School, Rockford.

INDIANA: **Indiana Section of the A. C. S.:** WM. HIGBURG, *Chairman;* C. T. HARMAN, *Secretary,* 111 East 18th St., Indianapolis.

IOWA: **Ames Section of the A. C. S.:** J. A. WILKINSON, *Chairman;* H. A. WEBBER, *Secretary,* 2331 Donald St., Ames.

Iowa Section of the A. C. S.: H. L. OLIN, *Chairman;* W. G. EVERSOLE, *Secretary,* University of Iowa, Iowa City.

KANSAS: **Kansas City Section of the A. C. S.:** J. E. WILDISH, *Chairman;* PERCY F. BALFOUR, *Secretary,* 718 W. Waldo Ave., Independence, Missouri.

Kansas State College Section of the A. C. S.: H. W. BRUBAKER, *Chairman;* A. T. PERKINS, *Secretary,* Kansas State Teachers' College, Manhattan.

Wichita Section of the A. C. S.: JOHN M. MICHENER, *Chairman;* D. EMERY COLWELL, *Secretary,* 718 W. K. H. Bldg., Wichita.

KENTUCKY: **Kentucky Association of Chemistry Teachers:** V. F. PAYNE, *Chairman;* H. J. ROBERTSON, *Secretary,* Augusta Tilghman High School, Paducah.

LOUISIANA: **Louisiana Section of the A. C. S.:** W. O. GRIFFEN, *Chairman;* H. O'DONNELL, *Secretary,* Room 324, U. S. Customs House, New Orleans.

MAINE: (*See* **New England States**).

MARYLAND: **Maryland Section of the A. C. S.:** A. A. BACKHAUS, *Chairman;* W. C. MOORE, *Secretary,* Box No. 1103, Baltimore.

MASSACHUSETTS: (*See* **New England States**).

MICHIGAN: **Michigan College Chemistry Teachers' Association:** D. L. RANDALL, *Chairman;* A. B. DOW, *Secretary,* Junior College, Grand Rapids.

MINNESOTA: **Minnesota Section of the A. C. S.:** S. C. LUND, *Chairman;* R. E. KIRK, *Secretary,* University of Minnesota, Minneapolis.

MISSOURI: **Kansas City Section of the A. C. S.:** J. E. WILDISH, *Chairman;* PERCY F. BALFOUR, *Secretary,* 718 W. Waldo Ave., Independence.

St. Louis Section: C. F. CARRIER, *Chairman;* H. A. CARLTON, *Secretary,* Mallinckrodt Chemical Works, St. Louis.

University of Missouri Section of the A. C. S.: A. J. HOGAN, *Chairman;* L. D. HAIGH, *Secretary,* 1617 Cauthorn Ave., Columbia.

MONTANA: **Montana Section of the A. C. S.:** EDMUND BURK, *Chairman;* JESSIE RICHARDSON, *Secretary,* State College, Bozeman.

NEBRASKA: **Nebraska Section of the A. C. S.:** D. J. BROWN, *Chairman;* E. J BOSCHULTE, *Secretary,* University of Nebraska, Lincoln.

NEVADA: **Science Division of the Nevada State Teachers' Institute:** G. W. SEARS, *Chairman;* E. C. STRENG, *Secretary,* 766 West Street, Reno.

NEW ENGLAND STATES: New England Association of Chemistry Teachers: J. S. CHAMBERLAIN, *Chairman;* OCTAVIA CHAPIN, *Secretary,* Malden High School, Malden, Massachusetts.
Central Division: F. R. BUTLER, *Chairman;* Worcester Polytechnic Institute, Worcester, Massachusetts.
Northern Division: LORNE F. LEA, *Chairman,* St. Paul's School, Concord, New Hampshire.
Southern Division: J. W. INCE, *Chairman,* Rhode Island State College, Kingston, Rhode Island.
Western Division: E. C. WEAVER, *Chairman,* Bulkley High School, Hartford, Connecticut.

NEW HAMPSHIRE: (*See* **New England States**).

NEW JERSEY: New Jersey Science Teachers' Association: ANNIE P. HUGHES, *Chairman;* PAUL D. TSCHUDY, *Secretary,* Senior High School, Atlantic City.

NEW MEXICO: Teachers' Association: J. D. CLARK, *Chairman,* State University of New Mexico, Albuquerque.

NEW YORK: Cornell Section of the A. C. S.: J. R. JOHNSON, *Chairman;* C. W. MASON, *Secretary,* Cornell University, Ithaca.
Eastern New York Section of the A. C. S.: C. G. HURD, *Chairman;* R. H. KIENLE, *Secretary,* General Electric Company, Schenectady.
New York City Section of the A. C. S.: R. R. HENSHAW, *Chairman;* S. P. BURKE, *Secretary,* 52 East 41st Street, New York City.
Rochester Section of the A. C. S.: E. M. BILLINGS, *Chairman;* H. W. CROUCH, *Secretary,* Building 14, Kodak Park, Rochester.
Syracuse Section of the A. C. S.: C. R. MCCROSKY, *Chairman;* NEAL A. ARTZ, *Secretary,* Bowne Hall, Syracuse University, Syracuse.
Western New York Section of the A. C. S.: R. B. MCMULLIN, *Chairman;* C. A. VINCENT-DAVISS, *Secretary,* Carborundum Company, Niagara Falls.

NORTH CAROLINA: North Carolina Section of the A. C. S.: F. K. CAMERON, *Chairman;* L. B. RHODES, *Secretary,* Department of Agriculture, Raleigh.

NORTH DAKOTA: Teachers' Association: E. S. REYNOLDS, *Chairman;* G. A. ABBOTT, *Secretary,* University of North Dakota, Grand Forks.

OHIO: Ohio State Chemistry Teachers' Association: ERWIN H. SHADE, *Chairman;* ROY J. GRADY, *Secretary,* Wooster College, Wooster.

OKLAHOMA: Oklahoma Section of the A. C. S.: H. M. TRIMBLE, *Chairman;* S. R. WOOD, *Secretary,* Agricultural and Mechanical College, Stillwater.

OREGON: Oregon Section of the A. C. S.: F. H. THURBER, *Chairman;* R. A. OSBORNE, *Secretary,* 227 South Seventh St., Corvallis.

PENNSYLVANIA: Central Pennsylvania Section of the A. C. S.: HARRY H. GEIST, *Chairman;* H. O. TRIEBOLD, *Secretary,* Pennsylvania State College, State College.
Erie Section of the A. C. S.: C. H. REESE, *Chairman;* J. L. PARSONS, *Secretary,* Hammermill Paper Company, Erie.
Lehigh Valley Section of the A. C. S.: H. A. NEVILLE, *Chairman;* J. G. SMULL, *Secretary,* 66 W. Greenwich Street, Bethlehem.
Philadelphia Section of the A. C. S.: E. C. BERTOLET, *Chairman;* L. L. JENNE, *Secretary,* 825 City Hall Annex, Philadelphia.
Pittsburgh Section of the A. C. S.: F. E. MARBACHER, *Chairman;* ARTHUR SCHRODER, *Secretary,* 711 Forbes Street, Pittsburgh.

RHODE ISLAND: (*See* **New England States**).

SOUTH CAROLINA: South Carolina Section of the A. C. S.: C. A. HASKEN, *Chairman;* H. E. STURGEON, *Secretary,* Presbyterian College, Clinton.

SOUTH DAKOTA: South Dakota Education Association: R. O. DOTT, *Chairman;* RALPH E. DUNBAR, *Secretary,* Dakota Wesleyan University, Mitchell.

TEXAS: Central Texas Section of the A. C. S.: J. C. GODBEY, *Chairman;* G. S. FRAPS, *Secretary,* Agricultural and Mechanical College, College Station.

UTAH: Utah Section of the A. C. S.: A. M. GANDIN, *Chairman;* C. R. KINNEY, *Secretary,* 1430 East Thirteenth Street, Salt Lake City.

VERMONT: (*See* **New England States**).

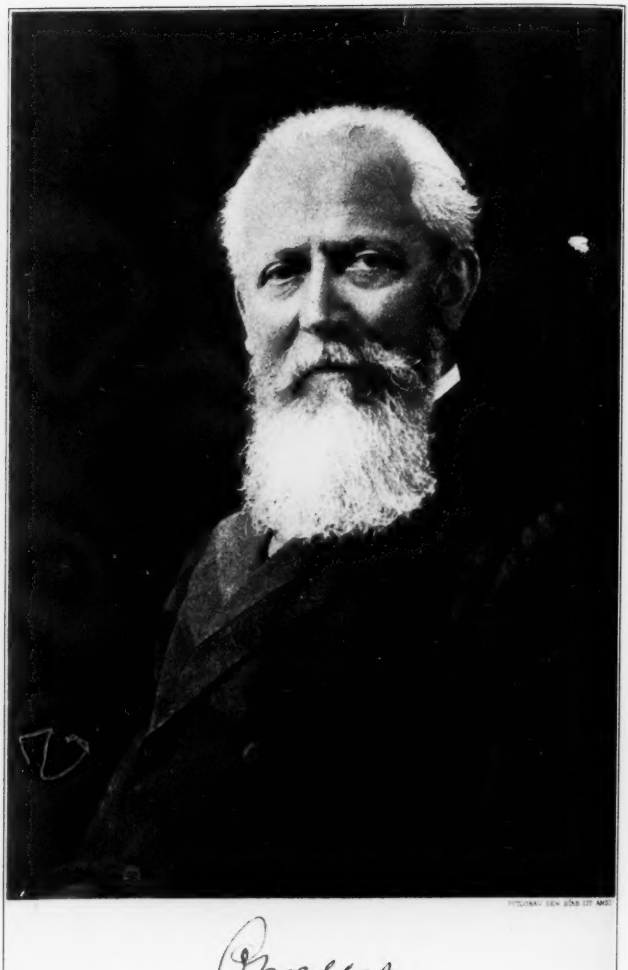
VIRGINIA: Virginia Section of the A. C. S.: EDWIN COX, *Chairman;* BRAXTON VALENTINE, *Secretary,* Valentine Meat Juice Company, Richmond.

WASHINGTON: Washington State Association of Chemistry Teachers: H. E. GAINES, *Chairman;* V. L. CLARK, *Secretary,* Stadium High School, Tacoma.

WEST VIRGINIA: Teachers' Association: F. E. CLARK, *Chairman;* HERBERT MCMILLAN, *Secretary,* Morgantown.

WISCONSIN: Wisconsin Chemistry Teachers' Association: I. W. JOHNSON, *Chairman;* S. EDITH BROWN, *Secretary,* North Division High School, Milwaukee.

XUM



O. Wallach.

EDITOR'S OUTLOOK

FORTY-SIX years ago an inquisitive professor of pharmaceutical chemistry at the University of Bonn asked permission to use some flasks of essential oils that had laid neglected on Kekulé's shelves for fifteen years. Kekulé, with a skeptical laugh, granted the permission, and the inquisitive professor, Otto Wallach, realizing the importance of these products in pharmacy, set to work upon an investigation of the chemistry of terpenes. It was a field about which very little was known in 1884. Seven years later Wallach gave the first report of his studies before the Deutsche Chemische Gesellschaft, and the analyses which he then discussed, with his continued pursuit of this research, formed a groundwork for the synthesis of aromatic chemicals, which has subsequently attained universal application in the manufacture of drugs, perfumes, and spices.

Otto Wallach, 1847–

Wallach was born in Königsberg, Prussia, on March 27, 1847. He studied at Göttingen under Wöhler, Hübner, and Hofmann. A responsive pupil to exceptional masters, he obtained his doctor's degree at Göttingen in 1869. A short period of industrial analytical work preceded his appointment as assistant to Kekulé at Bonn, where he remained for seventeen years, first as *privatdocent*, later as professor of pharmaceutical chemistry. In 1889 he returned to Göttingen, succeeding to the chair of Wöhler and Victor Meyer. Here his teaching and research progressed with continued success. In 1909 he was awarded the Nobel prize in chemistry "in recognition of the services rendered by him to organic chemistry and the chemical industry, through his pioneer work in the field of azoxy compounds."

Although Dr. Wallach retired some time ago from the duties of teaching, he is still a familiar and active figure in his research laboratory at Göttingen. His has been the serene existence of the man whose life has been marked by singleness of purpose, and on whom popular acclaim has had no influence. This is evidenced by his insistence that the celebration held in honor of his hundredth publication in the *Annalen der Chemie* in 1909 should be attended only by a restricted circle of his students. Monetary rewards have been so removed from his ambition that the results of his work, which have been of such vast importance to industry, have remained unpatented. A scion of a generation that is past, he retains the outlook and manners of other days and times. Although his activities have had definite boundaries, his educational background did not suffer from the narrowness so often deplored in the products of our modern systems, which strain so hard after an opposite result. His interests therefore have been broad, and his personality correspondingly attractive. Professional accomplishment and personal attachments—these are what he has looked for in life and these are what he has found.

The Journal gratefully acknowledges its indebtedness to Mr. Sederholm,

managing director of Nobelstiftelsen, Stockholm, Sweden, for the accompanying photograph of Dr. Wallach.

IN THE *Journal of Higher Education* for March, Professor Harold F. Clark presents a neatly executed bit of destructive criticism which strikes us as worthy of the widest possible dissemination.

Does Education Pay?

For some time it has been the fashion in certain quarters to stress the idea that education "pays" the individual in an economic sense. This is a piece of propaganda for education which we have always instinctively disliked. We are not so unworldly as to believe that any increase in honestly acquired income is other than highly desirable but we do feel that it is a case of misplaced emphasis, to say the least, to stress economic return as the chief benefit to be derived from education. It may be that the depravity or the blindness, as the case may be, of the propagandists who adopt this line of attack is not quite of the nature one might at first suppose. Perhaps they believe it justifiable to use a bait which is both comprehensible and attractive to the barbarian mind in order to lure the unlettered into acquiring benefits that he knows not of, but which it is hoped he will learn to comprehend and appreciate in the process of acquisition. If so, they are on uncertain ground, for it is always dangerous, to say nothing of intellectually immoral, to have two reasons—a real and an ostensible one.

Even granting the economic propagandists a worthy aim and a certain degree of psychological insight, there are signs that they have at times defeated themselves. It is not unreasonable to say that the lad who studies "business English," but who can see no practical value in Shakespeare is one of the deplorable by-products of the attitude which they have sponsored.

But Professor Clark does not waste time in discussing the question from this angle. He at once sets to work to cut the ground from under the feet of the educational economists by demonstrating that their argument is, *per se*, fallacious.

A composite chart compiled by Professor Clark from statistics presented in the studies of various investigators raises a number of interesting questions—if we take such figures seriously at their face value. The curves show that while the average maximum income of masters of arts and science and of doctors of philosophy is considerably above that of high-school graduates, which, in turn, is above that of grade-school graduates, that of bachelors of arts and science is considerably higher than any of the others. Is there an optimum amount of education

which one may not exceed without prejudice to one's economic interests? Does education beyond the baccalaureate degree diminish earning powers? Why, then, is the average income of doctors of philosophy somewhat greater than that of masters?

The chart further indicates that the general trend in earning power for grade-school and high-school graduates is upward until about the fiftieth or fifty-fifth year, when a gradual decline sets in. Doctors of philosophy and masters begin to fall off at the forty-fifth year, whereas bachelors continue to increase in earning power up to the sixty-fifth year, further than which the chart sayeth not. What do these figures mean?

To paraphrase Lewis Carroll, we shall save a deal of time by first inquiring whether they mean anything at all. According to Professor Clark they mean precisely nothing. After citing a number of statistical studies on the relation of education and income he gets under way as follows:

> How have these estimates of the money value of an education been made? The most widely quoted studies have compared the earnings of a group of people which went on to school with the earnings of a group that did not go to school so long. Because the earnings of the group which went on to school were larger, the authors of the studies concluded that schooling had some part in producing that result. What do we know about the ability of the two groups, what about the family connections, the business openings, the inherited wealth, and other advantages of the group that went on to school as compared with an average group?
>
> A certain class that had been out of one of our best colleges for ten years had an average income of $12,000. We should doubtless be told that the college education had produced that result. Such an income is easy to obtain if your parents will give you securities to produce most of it. The boys who go to college have larger incomes in later life than the boys who do not go. What of it? Boys who own private yachts, and boys who go to expensive private schools also seem to have larger incomes than the average boy. There even seems to be evidence to show that boys who go to expensive summer resorts have larger incomes in later life than boys who work in the summer. Does this mean that boys should not work in the summer? If the people who have made the studies of wages and schooling wanted to know the effect of schooling, why did they not equate two groups in regard to other factors than schooling? This was not done. For this reason I do not see how the results of the studies can be accepted.

Professor Clark continues, piling up facts and figures to the further confusion of the economic propagandists. Finally, he proceeds to emphasize a fact so obvious that we are at a loss to understand how it can be so universally ignored—namely, that the law of supply and demand continues to operate. The more we stress the economic returns to be expected from education, the more shall we attract the seekers after passports to white-collar and professional occupations. Already the market for teachers, for clerks, and for other more or less educated workers is worse than glutted. If the propagandists have ever been right,

they have worked from the beginning as assiduously as possible to make themselves wrong.

Professor Clark does not deny, nor do we, that education may be an economic asset, but it is not automatically so. Perhaps, if we still believe that education necessarily contributes any benefit whatever to any and all comers, we had better try to find out what that benefit really is and play it up on its own merits.

"Question Nature, Not Books"

IT SHOULD be news to no one that elementary laboratory instruction in the sciences, including chemistry, leaves much to be desired. Perhaps, to many, a discussion of what might be done to remedy the situation would be more acceptable than any enlargement upon the defects of the present system. It is true that there already exists a certain degree of healthy dissatisfaction. There are tentative gropings and even some bold and intelligent efforts toward more rational and more effective laboratory teaching. It does not seem to us, however, that the general complacency with the *status quo* has as yet been sufficiently disturbed to render further criticism altogether pointless. Hence we have no hesitation in presenting here a quotation which in our opinion goes straight to the root of the matter.

Professor Ralph W. Gerard,[1] in preface to a description of a method of laboratory instruction which he has newly employed in his physiology course at the University of Chicago, writes as follows:

> Fifty years ago Louis Agassiz said, "Question Nature, not books," and called into being the modern laboratory courses of science. Now youth learns chemistry with the Bunsen burner and biology with the scalpel, and scientists are haughty to philosophers.
>
> The method of teaching by doing is certainly an improvement over that by exposition, but how grotesquely has the meaning of Agassiz's dictum been warped. For example, a class is learning how to test for arsenic. Before commencing the experiments the students are expected to have read, and often have, about the various reactions of this substance. In the laboratory they slavishly follow careful directions for proceeding. "Take 10 cc. of arsenic trichloride solution; add 10 cc. of concentrated hydrochloric acid, and warm to 70°C. Pass in hydrogen sulfide gas for 10 minutes. Observe the formation of a yellow precipitate of arsenic sulfide." Miss Y obtains no yellow precipitate; she used a dilute instead of a concentrated acid, but does not know this. Nature, as interrogated by Miss Y, says that arsenic does not have an insoluble yellow sulfide; the book says it does. And what does Miss Y say? "Oh, there must have been something wrong with the experiment." Miss Y would probably not remember arsenic sulfide very long even if her experiment had succeeded, but she would never forget that iron sulfide is black, for during the arsenic experiment she put her

[1] *Univ. Chi. Mag.*, **22**, 143–6 (Jan., 1930); Reprinted, *J. Higher Educ.*, **1**, 193–7 (April, 1930).

head into the hydrogen sulfide gas and when she withdrew it her artistically rouged cheeks and lips had become quite black. That was a real discovery.

So common is this experience that students regularly distrust their own observations and experiments, and when they pass on and perhaps become instructors, the state of mind persists. A friend teaching at Cambridge University told me of a particular experiment, a test of the action of some drug, that had been demonstrated to every class of medical students for a quarter of a century. For years he, as his predecessors, had failed in test experiments to obtain the expected effect and had always put across the actual demonstration by silently adding a different drug that did produce the results. Finally, he became sufficiently exasperated to study seriously the action of this drug, and proved that it had no such effect. The often "demonstrated" test was an "error that had crept into the literature of the subject," but the books had overpowered the observations of a generation of university students. . . . .

A further evil has crept into laboratory teaching and teaching in general, which is perhaps a reverberation from the present century lapping about our island universities. The period is filled to overflowing with things to be done. Dozens of separate, often unrelated, experiments are packed into one afternoon period so that the mere manual execution of them requires some dispatch. Active thought about them, even if encouraged, is then pretty much out of the question, and the actual doing is degraded to little more than drudgery. As an aid to teaching, such laboratory work is yielding meager returns on the time and capital invested in it.

I have painted, perhaps, an extreme picture of laboratory teaching today, but certain valid conclusions, I believe, remain. The spontaneous interest of normal beings is stamped out, almost methodically, by having everything labeled and docketed beforehand. The student knows what to expect. If it happens, what of it? He knew it would, and there is no time to think about it now. If it does not, what of it? It should have; something must have been wrong, but there is no time to do it over. In truth we teach our students to question Nature, not books—to question what she tells us.

Professor Gerard proceeds to outline the method which he has adopted and to describe the results obtained in a year's trial. In another paper[2] Professor H. H. Whetzel of Cornell University tells in more detail of a course in plant pathology, similar in spirit but differing somewhat in method from that of Professor Gerard. Both of these papers well deserve reading in full by high-school as well as college teachers of the experimental sciences.

The chemistry instructor probably will not find that he can transfer either of these methods bodily to the chemical laboratory, but we believe he *will* find that both of them contain practical suggestions of which he can make use.

[2] *J. Higher Educ.*, **1**, 125–35 (Mar., 1930).

THE DIALYZER

1. Who was the founder of modern terpene chemistry? (pp. 1224–6, 1421.)

(*For questions* 2–5 *see* pp. 1231–48.)

2. What well-known German chemist, who died as recently as 1917, began his teaching career at the age of nine? How did he take care of his pupil's tuition fees?
3. Who discovered arsenic monomethyl chloride?
4. What relation exists between indol and indigo?
5. At whose suggestion and by whom was anthracene first prepared by the reduction of alizarin?

(*For questions* 6–10 *see* pp. 1249–62.)

6. How do cylinders designed to contain combustible gases differ in construction from those designed to contain other gases?
7. How are the reducing regulators on gas cylinders operated?
8. If you and your colleague simultaneously needed for demonstration experiments a certain gas, of which there was available only one cylinder, how would you store a supply sufficient for your needs?
9. How would you proceed to dry a gas? What drying agent would you choose, if the gas were acid? If neutral? If basic?
10. How would you arrange the cylinder to collect a liquid gas? A solid gas?

(*For questions* 11–13 *see* pp. 1263–76.)

11. What is the principle underlying the process of lithography?
12. What large industry of today had "mother's laundry list" as its starting point?
13. By what process may a photograph be produced lithographically?

(*For questions* 14–16 *see* pp. 1277–90.)

14. How is peanut butter made?
15. How may the separation of the oil from the peanut butter be prevented?
16. Does the nutritive value of peanut products warrant their extensive consumption?
17. What are ammono alcohols? (pp. 1291–9.)
18. Are you looking for a method of demonstrating the decolorizing action of carbon? (p. 1299.)
19. What contemporary chemist has contributed extensively to our knowledge of the element zirconium? (pp. 1300–4.)
20. How may high-school chemistry students be trained to drill themselves? (pp. 1315–6.)
21. Distinguish between the terms association and polymerization. (pp. 1322–3.)
22. Would you be interested in a chemistry contest designed to include several schools? (pp. 1324–6.)
23. Have you exhausted your ideas for programs, experiments, demonstrations, etc., for science club activities? (pp. 1329–31.)
24. Who was Richard Chenevix? (p. 1333.)
25. Are you contemplating purchasing equipment for picture projection in the classroom? (pp. 1341–8.)
26. What aspects of chemical education are engaging the major interest of the Division of Chemical Education of the A. C. S. at the present time? (pp. 1351–5.)
27. Why may the structural analysis of crystals on the basis of X-ray data be described as a process of elimination? (pp. 1373–84.)

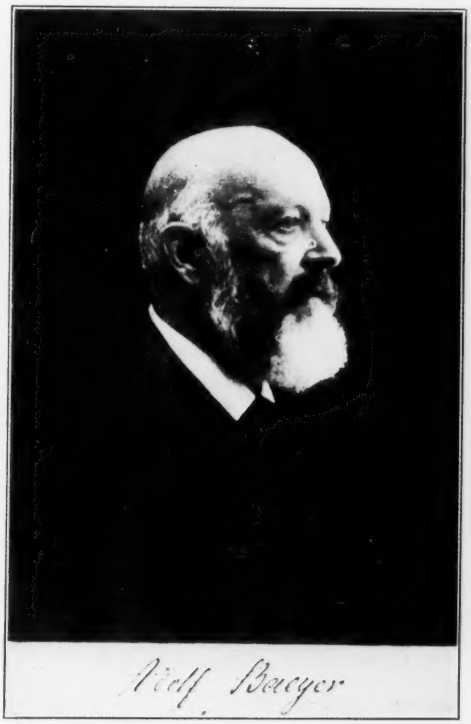
(*For questions* 28–29 *see* pp. 1388–99.)

28. How could you prepare a positive print from a photographic negative if you had available only paper, dichromated gelatin, and powdered carbon?
29. How does the photographer achieve the sepia tint often seen in photographic portraits?
30. What chemistry exhibit is being planned for the Chicago World's Fair in 1933? (pp. 1429–30.)
31. What are the details of the loan fund recently established at the Missouri School of Mines and Metallurgy? (pp. 1436–7.)

ADOLF VON BAEYER (1835–1917)*

FERDINAND HENRICH, UNIVERSITY OF ERLANGEN, ERLANGEN, GERMANY

The most eminent organic chemist in Germany during the latter part of the nineteenth and the early part of the twentieth century was Adolf von Baeyer.[1] His reputation is international. His important discoveries stamp him as an experimenter of the first rank. He also excelled as an interpreter of organic reactions; he amplified Kekulé's theories, and his theoretical conceptions are still of value. Furthermore, he was a distinguished teacher who understood the art of developing his students. He had a flair for inspiring enthusiasm, for recognizing latent talent and for molding his pupils into investigators and teachers. Consequently, many of the most noted organic chemists had studied under him. Among them were C. Graebe, C. Liebermann, Victor Meyer, Emil Fischer, M. Nencki, L. Claisen, H. von Pechmann, E. Bamberger, Johannes Thiele, R. Willstätter, H. Wieland. Early in his teaching career he organized an exemplary system of chemical education at his laboratory in Munich. He realized the necessity of definitely determining the student's progress at stated intervals



PHOTOGRAPH OF BAEYER IN 1905

Baeyer received a patent of nobility early in the nineties and from that time on was called von Baeyer. While appreciative of the honor, he placed no great value on this distinction.

* Translated by RALPH E. OESPER, University of Cincinnati, Cincinnati, Ohio. Prof. Oesper also furnished the information contained in the captions of the illustrations accompanying this article.

[1] For additional material on Baeyer see THIS JOURNAL, **6**, 1380–3 (Sept., 1929); also **6**, 1829 (Oct., 1929).

by formal examinations. This new plan was adopted by the "*Verband*" of the Directors of the German Laboratories and served as the basis of the present "*Verbandsexamina*" which all German chemical students must pass.

It is of great psychological and practical interest to trace the path by which this gifted man, this pioneer in many fields of chemical research, rose to such heights. Adolf Baeyer was born October 31, 1835, in Berlin. His father, a well-educated general, had collaborated with the astronomer Bessel in determining the length of an arc of meridian. His mother was the daughter of the criminologist and literary historian, Hitzig, whose house had been the rendezvous of such poets as E. T. A. Hofmann, Chamisso, etc., and many other people interested in literature. So as a boy Baeyer came into intimate contact with men like Heyse, Geibel, and Fontane. It would have been natural for the son of such a mother to have had literary tendencies, but the opposite was the case. He showed no interest in literature, but at an early age derived a great deal of pleasure from the study of nature and from the performance of simple chemical experiments. These gradually became a source of danger for he used the lamps, fire tongs, and other household utensils. When even corporal punishment had no effect on this urge for experimentation, his father gave him Stöckhardt's "School of Chemistry" for his ninth birthday. To the boy's great delight, he was also permitted to fit up a laboratory.[2] Here he performed all the experiments in the book and delivered lectures on chemistry to one of his comrades who worked out his tuition fees by washing the dirty apparatus.

At the *Gymnasium*, the teacher who especially attracted Baeyer was K. Schellbach, teacher of mathematics and physics, who chose Baeyer as his assistant and permitted him to demonstrate chemical experiments to his fellow pupils. After passing his final examinations, Baeyer entered the University of Berlin and specialized in mathematics and physics. The mathematical lectures of Dirichlet particularly appealed to him. The clear, polished manner of presentation and especially the way Dirichlet made his audience really think greatly impressed Baeyer. Later, in his own teaching, he adopted and improved this same method which was largely responsible for his success in producing teachers and investigators.

Baeyer did not turn definitely to chemistry until after he had finished his military service. There was then no laboratory in Berlin with organized chemical courses, and consequently he went to Heidelberg to study

[2] The conflict between the literary and chemical atmosphere in this household led to the well-known jingle of Heyse:

"Es stinkt in diesem Haus gar sehr
Das kommt von Adolf Baeyer her."

See H. Wieland, *Chem.-Ztg.*, **39**, 829 (1915).

under Bunsen.[3] There he followed the usual curriculum. Because of his previous training, largely due to his own efforts, he soon acquired sufficient skill in qualitative and quantitative analysis, and Bunsen then assigned him a problem on idiochemical induction. His results were incorporated in Bunsen and Roscoe's well-known papers on photo-chemical investigations.

There were at this time a number of young men in Bunsen's laboratory who later became well known: Roscoe, Lothar Meyer, Pebal, Lieben, Beilstein, etc. One day Pebal told Baeyer that Bunsen had assigned to him a research on the alleged varieties of methyl chloride resulting from different methods of preparation, but since he was not interested in this problem, Pebal asked Baeyer if he would be willing to take over the investigation. Baeyer agreed and from that time devoted himself almost exclusively to organic chemistry. Since Bunsen had long since given up organic chemistry, his laboratory had now little attraction for Baeyer. But in the meantime, there had come to Heidelberg one who lectured on organic chemistry from a new standpoint. He had the fire and eloquence of a prophet and he was exerting an increasing influence on the development of this branch of chemistry. This enthusiast was August Kekulé.[4] His lectures revealed a new world to Baeyer, who said, "Borne along by the logical coherence of the new doctrine, later known as structural chemistry, Kekulé erected in the presence of his enraptured audience, the edifice of theoretical chemistry in which we still live."

Baeyer therefore decided to work under Kekulé. Since Bunsen had gradually eliminated organic chemistry from his laboratory and there was no place there for an organic chemist, Kekulé was forced to fit up a private laboratory.[5] This was extremely modest, consisting of a room with a single window and two laboratory desks and an adjoining kitchen which served as a fume chamber. The fireplace there furnished the only draft. Baeyer was Kekulé's first student here (1857). During his study of methyl chloride, Baeyer had prepared a rather large quantity of caco-

[3] "Robert Wilhelm Bunsen," R. E. Oesper, THIS JOURNAL, **4**, 428, 431–9 (Apr., 1927). For pictures of Bunsen's laboratory, office, and lecture room see *Ibid.*, **6**, 219 (Feb., 1929). See also "My Student Days in Germany," L. W. McCay, *Ibid.*, **7**, 1094–9 (May, 1930).

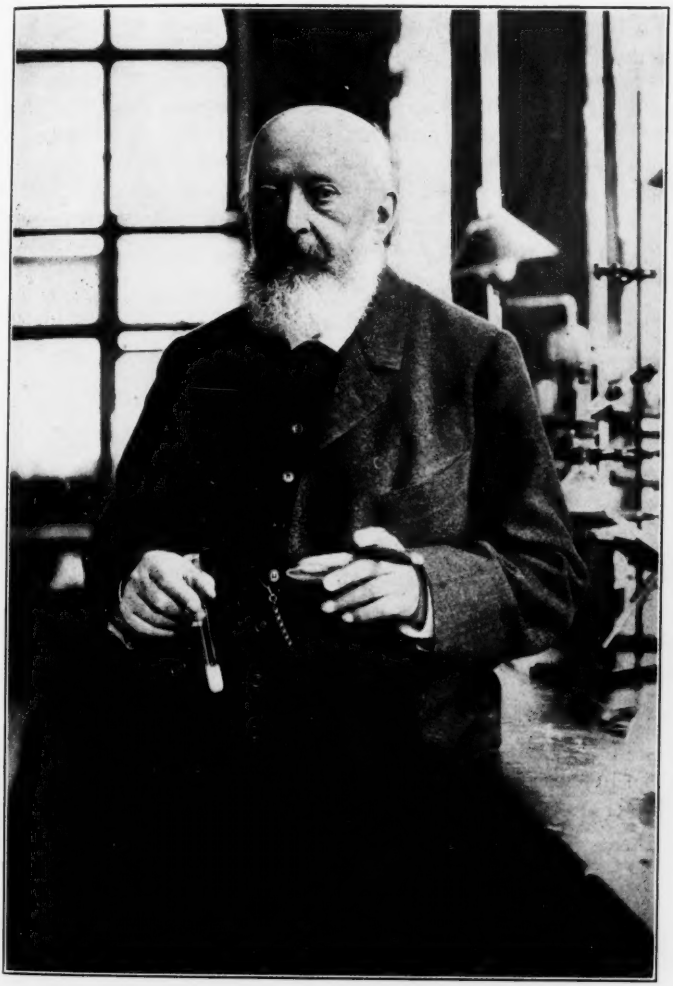
[4] For additional material on Kekulé, see THIS JOURNAL, (1) Abstract of "The Faraday Benzene Centenary and Kekulé," **2**, 939 (Oct., 1925); (2) "August Kekulé," Ludwig Darmstaedter and R. E. Oesper, **4**, 693, 697–702 (June, 1927); Abstract of "Kekulé and His Hexagon," **4**, 794–5 (June, 1927); "The Liebig House and the Kekulé Room at Darmstadt," E. Berl and R. E. Oesper, **6**, 1869–81 (Nov., 1929). This latter article contains several references to material on Kekulé.

[5] In this connection see the interesting account of the early laboratories at Heidelberg by A. Bernthsen, *Z. angew. Chem.*, **42**, 382 (1929); see also "The Study of Chemistry at Heidelberg: A Glimpse of an Historic Home of Research," Karl Freudenberg, THIS JOURNAL, **4**, 441–6 (Apr., 1927).

dylic acid and he decided to use this in his first independent research. When he had asked one of his colleagues in Bunsen's laboratory what could be done with cacodylic acid, the answer had been, "It is the fashion nowadays to treat everything with phosphorus pentachloride." Consequently, Baeyer tried this reaction in Kekulé's laboratory. It is not surprising that the poisonous vapors generated were only partially carried off through the fireplace. Most of the fumes remained in the kitchen and enough of them were inhaled by the young experimenter to give him a slight, though permanent, injury. Kekulé found him one day with his face badly swollen, half stupefied, and unable to call for assistance. He had discovered arsenic mono-methyl chloride and had inhaled too much of it. After this occurrence, arrangements were made for him to prepare this compound on a somewhat larger scale in a better ventilated fume chamber of another private laboratory. By Easter, 1858, he had completed this investigation.

Quite proud of this achievement, Baeyer returned to Berlin and offered the results of this dangerous research to the University there as his doctorate dissertation. However, the outcome was not what he had anticipated. E. Mitscherlich, Heinrich Rose, and the physicist, Gustav Magnus, who in other matters treated him with almost fatherly affection, gave him more criticism than praise and received his thesis rather coldly, probably because they did not understand its objective. But he passed his oral doctorate examination creditably and then set out to follow Kekulé, who meanwhile had accepted a call to Ghent. En route Baeyer visited his married sister at Elberfeld and through her became acquainted with Adolf Schlieper, a factory owner. The latter had once worked with Liebig on uric acid and still had preparations dating from that time. He turned these over for further investigation to the young doctor, together with a sample of the product he had obtained by the action of potassium cyanide on picric acid. In Ghent, Baeyer took up a study of these specimens and found that Schlieper's compound was the potassium salt of iso-purpuric acid. He also finished a study of pseudo uric acid which he published jointly with Schlieper.

Shortly thereafter Baeyer completed his studies at Ghent and returned to Berlin where he delivered his habilitation lecture on uric acid. As there was no teaching laboratory in Berlin and as he did not have the means to fit up a private laboratory, he found it impossible at first to do any experimental work and was very much dejected, especially when no one registered for the lecture courses he so hopefully announced. However, one day the physicist Dove told him that a professorship of organic chemistry was to be established at the "*Gewerbe Akademie*," the predecessor of the present "*Technische Hochschule*." Baeyer applied for the position and was appointed, at a very modest salary, on October 1, 1862.



BAEYER IN THE LABORATORY ABOUT 1902

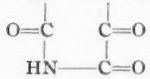
Through the support of Nottebohm, the Director of the Akademie, a roomy laboratory was fitted up for him so that he now could experiment as much as he wished. Baeyer was active here for twelve years and his systematic, well-planned diligence developed him into an investigator of higher order who did not fear to attack new fields.

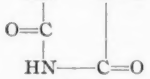
His laboratory and its enthusiastic head soon attracted young men of ability and many of these early attained a considerable measure of success, notably, C. Graebe, C. Liebermann, Victor Meyer, N. Nencki, etc. The instruction was not given in the routine pedagogical fashion. Each taught the others the things he himself knew best. It was rather a friendly collaboration and proved extremely fruitful and they all, in later years, remembered these days with pleasure.

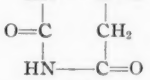
The conservative spirit dominating chemistry in Berlin disappeared with the death of H. Rose (1863) and E. Mitscherlich (1864) and a new era was ushered in when A. W. Hofmann was called to the University in 1865. He immediately entered into the most cordial relations with Baeyer. He was also instrumental in banding the younger chemists together by founding the "*Berliner Chemische Gesellschaft*" in 1868. The meetings were soon characterized by lively scientific discussions and the "*Nachsitzungen*" which followed these sessions afforded opportunity for stimulating fellowship.

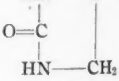
Because of his great scientific achievements and his remarkable discoveries, Baeyer was called to the newly founded University at Strassbourg in 1872. Liebig died in 1873 and the coveted professorship at Munich was offered to Kekulé, who preferred not to leave Bonn. Baeyer was then selected in 1875. He taught at Munich until his retirement forty years later. He soon became the leading organic chemist of Germany and remained so as long as he taught.

When Baeyer began his researches at the *Gewerbe Akademie*, it was only natural that he continued his study of uric acid (VI). Liebig and Wöhler had prepared a number of compounds from this material of which the most important were alloxan (mesoxalyl urea) (I) and parabanic acid (oxalyl urea) (II).


(I)

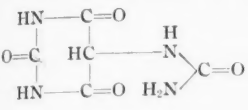

(II)


(III)

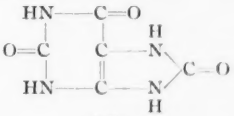

(IV)

Baeyer succeeded in preparing barbituric acid (malonyl urea) (III) and hydantoin (glycolyl urea) (IV) from uric acid and he also established their constitution by synthesis. He was anxious to prepare uric acid by starting with urea and going through the intermediate products. He actually

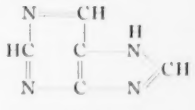
got as far as pseudo uric acid (V) which, by the loss of water, should produce uric acid. However, this reaction was not accomplished until almost a generation later when Emil Fischer, Baeyer's distinguished pupil, was more successful than his teacher. Fischer also converted uric acid into the proto-compound of the whole group, purine (VII).



(V)



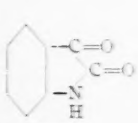
(VI)



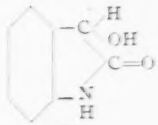
(VII)

One of Baeyer's best known researches which was of great importance to the development of organic chemistry was his study of indigo. In addition to the masterful elucidation of the product obtained by breaking down indigo, whose formula was definitely established by several syntheses, his study of the acetyl and methyl derivatives of isatin gave the first unquestionable examples of phenomena which later led to the development of tautomerism and desomotropism. Furthermore, the method involving distillation with zinc dust which has repeatedly played an important part in the unraveling of the constitution of complicated natural products was discovered during these researches. Later investigators used many other suggestions that had their origin in Baeyer's study of indigo.

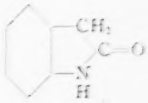
This dyestuff had had a fascination for Baeyer even as a boy. He always remembered with pleasure the lump of indigo he bought with his birthday money when he was thirteen and even at this early stage in his career, he prepared the principal scission product of indigo, isatin (VIII). This is produced by the oxidation of indigo and consequently it would seem only logical that the reduction of isatin might yield the compound from which indigo itself is derived. Consequently, Baeyer set to work to remove both the oxygen atoms from isatin. The usual methods accomplished the introduction of hydrogen and the removal of one oxygen atom. In this way, he produced dioxindol (IX) and oxindol (X).



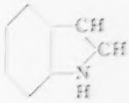
(VIII)



(IX)

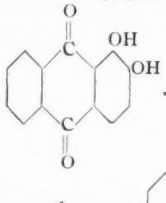
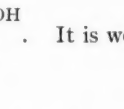


(X)

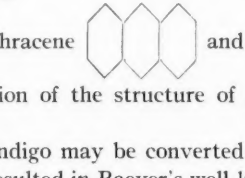


(XI)

However, when he attempted to remove the second oxygen atom, all known methods failed. "After six months of fruitless efforts," said Baeyer, "I told my difficulties to my colleague, Stahlschmidt, who at that time taught technical chemistry at the *Gewerbe Akademie*. He told me that

zinc dust, which previously had only been used as a pigment, had for some time been used in technical work as a reducing agent. I immediately tried this material, but the oxindol resisted all my efforts until, in despair, I heated the mixture almost to redness in a combustion tube." A sublimate collected in the forward end of the tube. This was the parent substance of indigo and Baeyer named it indol (XI). He had thus discovered a new method of radically deöxidizing organic compounds, and later suggested this procedure to his pupils Graebe and Liebermann, as a means of reducing alizarin  . It is well known that they thus succeeded in obtaining anthracene  and so cleared the way, not only for the determination of the structure of alizarin, but also for its preparation.

The knowledge that indigo may be converted into indol *via* the intermediate product isatin resulted in Baeyer's well-known indigo formula:



As early as 1870 Baeyer, in collaboration with Emmerling, had succeeded in converting isatin into indigo, and later he discovered several other methods of synthesizing this dyestuff.

Baeyer published (1870) his views concerning the removal of water from materials containing carbon, hydrogen, and oxygen. He compiled all the cases in which water might be lost by the union of a hydrogen atom and a hydroxyl group, and discussed the types of compounds which might thus be formed. In addition to the formation of true anhydrides corresponding to $\equiv C—O—C\equiv$, reactions, which he termed condensations, might also occur, producing compounds in which two carbon atoms might be joined by either single or double bonds. Even then, gaseous formaldehyde was represented by the formula H_2CO; but in aqueous solution it might combine with a molecule of water to form $CH_2(OH)_2$.

If it be assumed that an OH of one molecule combines with an H of another to form water, and if the carbon bonds thus set free combine with each other, the following equation may represent the results of such action involving six molecules.

$$6CH_2(OH)_2 - 5H_2O = C(OH)_2H{\cdot}C(OH)H{\cdot}C(OH)H{\cdot}C(OH)H{\cdot}C(OH)H{\cdot}C(OH)H_2.$$

If this then loses another molecule of water from the group $C(OH)_2$ on the left end there results:

$$COH{\cdot}[C(OH)H]_4{\cdot}CH_2OH$$

which corresponds to the empirical composition of grape sugar. . . . and therefore, it may be supposed that the formation of sugar in plants has some relation to the reaction just discussed. The usual assumption concerning the formation of sugar and of related materials in plants is that the carbonic acid is reduced in the green parts by the action of light and is converted into sugar by a gradual synthetic process.

It had been assumed by Baeyer's predecessors that organic acids such as formic, oxalic, tartaric, etc., appeared as intermediate products during the formation of sugar in plants. Baeyer thought this improbable and in place of this assumption he postulated that the sugar is formed directly from carbonic acid *via* formaldehyde, as shown above. This theory of assimilation still prevails.

The paper in which Baeyer developed this hypothesis contains a whole series of other speculations, of which one was destined to have particular significance. This dealt with the possibility of a reaction (condensation) between aldehydes and hydrocarbons, phenols, and other compounds. During a study of such reactions in Baeyer's laboratory, his pupil, Otto Fischer, condensed benzaldehyde with dimethyl anilin and thus produced leuco malachite green and the dye itself. On one occasion, Baeyer wished to remove the elements of water from several phenols which occur in vegetable materials. He used phthalic anhydride as the dehydrating agent. He found, however, that the phthalic anhydride entered into the reaction and Baeyer thus obtained a series of condensation products, the phthaleins, which have become important dyestuffs. The best known are phenolphthalein, formed by the action of the anhydride and phenol, and fluorescein and its brominated derivative, eosin, which are prepared from resorcinol. After laborious researches, he succeeded in elucidating the mechanism of this condensation and his views are basically those accepted today.

Baeyer studied the combining power of carbon more intensively than most of his fellow chemists. In order to determine whether carbon atoms which are not combined with hydrogen could unite to form chains and rings, he prepared a series of acetylene-like compounds. Typical of these is tetra-acetylene dicarboxylic acid, $HO_2C{\cdot}C{\equiv}C{\cdot}C{\equiv}C{\cdot}C{\equiv}C{\cdot}C{\equiv}C{\cdot}CO_2H$. This compound was found to be explosive, and his inquiry into the reason for this led to his famous "Strain Theory."

He started with the theory of van't Hoff-Le Bel that the valence bonds of carbon are directed toward the corners of a regular tetrahedron, and assumed that these directed valences would resist every deflection from this normal direction with a force directly proportional to such bending

CARTOON OF KEKULÉ, HEIDELBERG (1860)

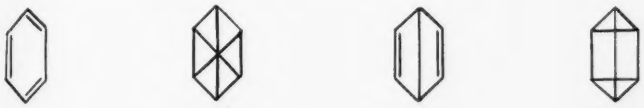
Such deflections may appear when carbon atoms are joined by double or triple bonds or when they unite to form rings. In the ethylenic linking, for instance, each valence bond shows a deflection of 54° 44′. If three carbons unite to form a ring (trimethylene), each of the affected valence bonds will be bent through an angle of 24° 44′. The formation of a tetra-methylene ring involves a deflection of only 9° 44′, while in the case of the pentamethylenes, the deflection is but 0° 44′. In the last case, the strain ensuing from the bending of the valence bonds is very slight, and consequently it might be expected that the resistance to the union of five carbon atoms to form a ring would be very little. This resistance or strain, however, would increase with the magnitude of the deflection, so that tetramethylene rings would be formed with more difficulty and the resistance would be still greater in the case of the trimethylene rings. When dealing with rings containing more than six carbon atoms, the valence bonds are not necessarily bent or not seriously so, if it be assumed that the atoms composing the ring do not lie in one plane, though such assumptions lead to the possibility of isomers that have not been realized.

This hypothesis did much to explain the behavior of ethylene and the polymethylenes, but has also led to numerous contradictions. Nevertheless Baeyer's "Strain Theory" has by no means outlived its usefulness. It is characteristic of Baeyer's theoretical interpretations that while they were far from perfect, they always contained a fundamental truth.

One of Baeyer's early researches dealt with benzene and its derivatives. He did not follow conventional lines but studied, for example, the hydrogenated benzene carboxylic acids. Later, investigations on the hydrogenation of the three isomeric phthalic acids, etc., especially occupied his attention and led to nine papers on the "Constitution of Benzene."

These discussions have become classics and are part of our chemical heritage.

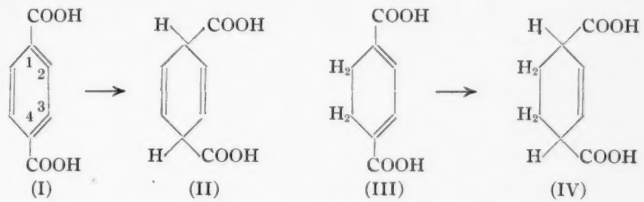
At that period, the discussions concerning the structure of benzene occasionally included the possible validity of Dewar's formula (III) and Ladenburg's prismatic formula (IV), as well as that of Kekulé (I) and the diagonal formula suggested by Claus (II).



(I) (II) (III) (IV)

Bayer believed that a decision as to the most suitable method of representation might be reached by studying the compounds resulting from the addition of atoms, hydrogen, for example, to the benzene ring. He assumed, of course, that this addition must occur at the extra carbon valences, which at the instant of combination would be momentarily freed. That is, the addition would take place on adjoining carbon atoms. However, in reality, the facts were often quite different from the anticipations.

In the case of terephthalic acid (I), the first two hydrogen atoms did not combine in the 1,2 position as was anticipated, but rather in the 1,4 position, so that the acid II resulted. Analogously, acid III, on reduction, produced acid IV.



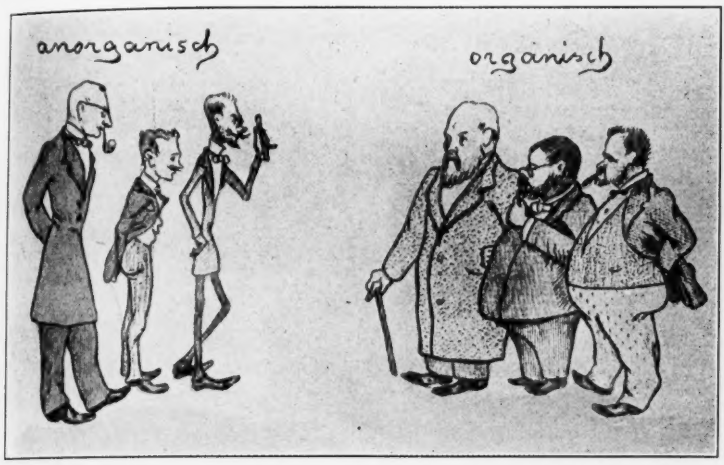
(I) (II) (III) (IV)

When, however, Baeyer studied the same relations in the aliphatic series, he found that also in the case of muconic acid, $HO_2C-\overset{1}{C}=\overset{2}{C}-\overset{3}{C}=\overset{4}{C}-CO_2H$, (H H H H) the two hydrogen atoms combined with carbon atoms 1,4 rather than 1,2. Later, in Baeyer's laboratory, Johannes Thiele sought to explain this behavior by means of his theory of partial valences, in which he assumed the existence of a conjugated linking between carbon atoms 2,3:

$$\overset{H\ H\ H\ H}{HO_2C\cdot C=C-C=C\cdot CO_2H.}$$
$$\underset{1\ \ 2\ \ 3\ \ 4}{}$$

GROUP OF FRIENDS AT BAEYER'S VILLA, STARNBERG, OCTOBER 6, 1895

Thiele — Mahly, Spiegel, R. Meyer, v. Pechmann — Fritzsch, Hantzsch, Muthmann, Bruhl, Bendemann — Lintner, Heymann, Burkhardt — Buchner, Besthorn, O. v. Baeyer — Bamberger, Curtius — Weiler, Frau v. Baeyer — F. Bayer, H. v. Baeyer, Frau v. Bruning, A. v. Baeyer — Bender, Friedlander ter Meer, Geigy — Hobein, Hepp, Goldschmiedt, Frau Dr. Piloty with son — Nothaass, O. Fischer, Glaser — Schraube — Knorr, Koenigs, Graebe — v. Bruning, Duisberg, Liebermann — Einhorn, V. Meyer



CARTOON OF BAEYER AND SOME OF HIS ASSOCIATES

The inspiration for this cartoon is evident from the cartoonist's comment—"Wirst, leicht sehen, welches Fach seinen Mann am besten nährt"—"It is easily seen which branch of chemistry best nourishes its man."

The subjects of this cartoon, reading from left to right, are PILOTY, HOFMANN, VANINO, V. BAEYER, KOENIGS, AND THIELE.

OSCAR PILOTY (1866–1914) was a pupil and assistant of Emil Fischer, and professor at Munich from 1899 to his death in battle on September 25, 1914. He was Baeyer's son-in-law. For biographical details see Harries, *Berichte*, **53A**, 153 (1920).

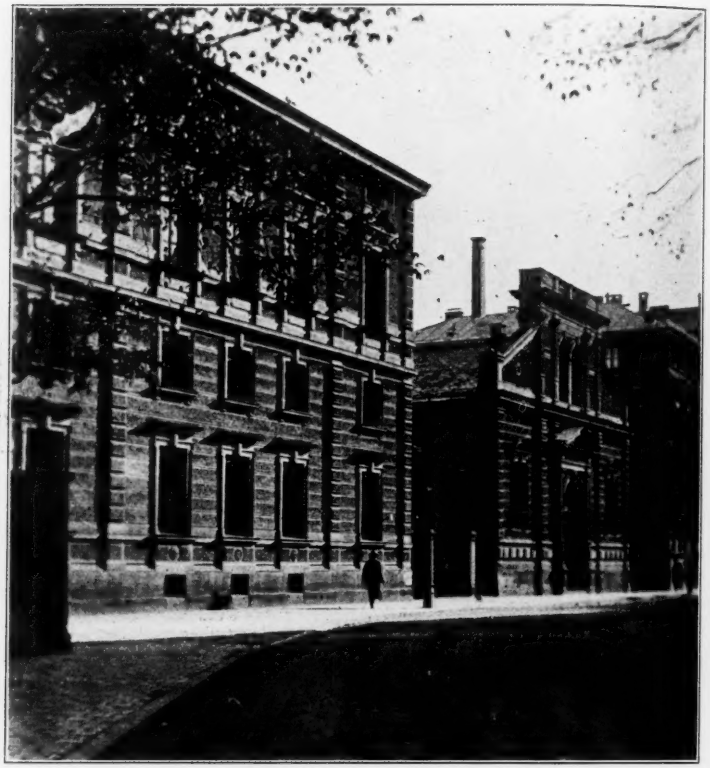
KARL A. HOFMANN (1870–) took his doctorate under Baeyer and taught at Munich from 1895–1910. He is now *ordinarius* in the Technische Hochschule, Charlottenburg, Berlin.

LUDWIG VANINO (1861–) studied at the University of Munich, where he has been professor and custodian of the laboratory for many years.

WILHELM KOENIGS (1851–1906) taught at Munich with Baeyer for thirty years. For an extended biographical account see Curtius and Bredt, *Berichte*, **45**, 378 (1912).

JOHANNES THIELE (1865–1918) was professor at Munich 1893–1901. For biographical details see Strauss, *Berichte*, **60A**, 75 (1927).

During the course of Baeyer's study of the benzene problem, he discovered a remarkable difference between true benzene derivatives and their hydrogenated derivatives. The latter no longer showed the relatively saturated characteristics of benzene derivatives but reacted like compounds of the aliphatic series. This could not be predicted on the basis of Kekulé's formula. In order to indicate that in true benzene derivatives the six extra valences of the six carbon atoms comprising the ring mutually saturate each other, Baeyer proposed the so-called centric formula for benzene . This formula ranks with that of Kekulé and has been



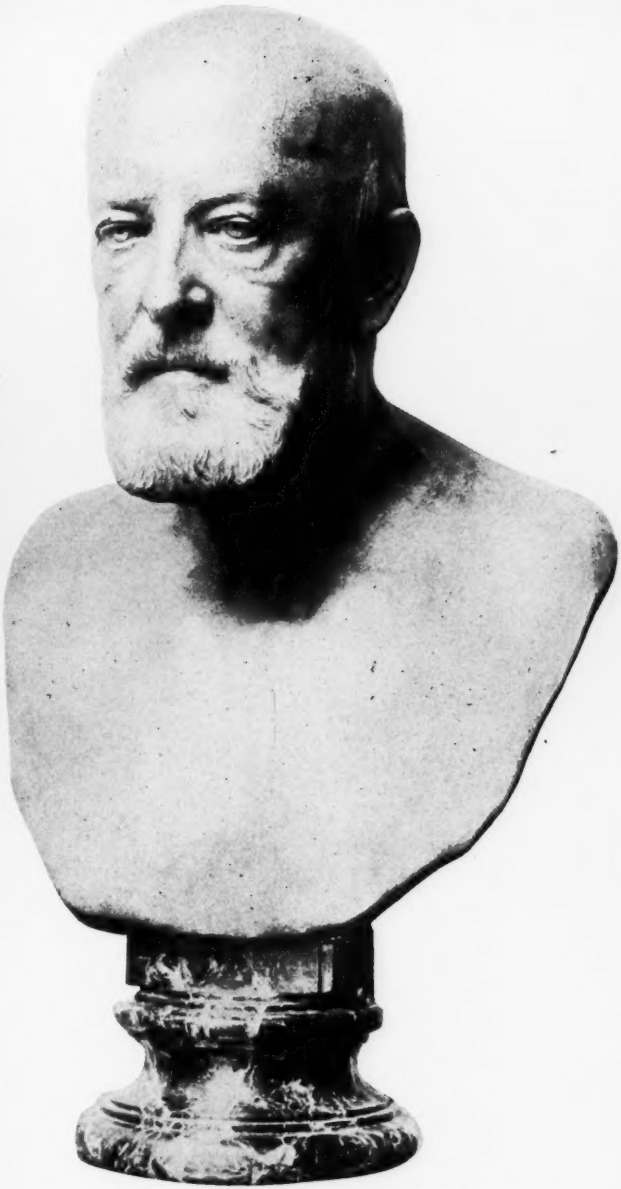
CHEMISCHES INSTITUT, MUNICH

The central structure was built under Liebig's direction. It was remodeled and enlarged by Baeyer. The building to the right is the Professor's "Wohnung."

interpreted by Thiele's benzene formula: .

Wallach and others showed that the terpenes were derivatives of hydrobenzene. Consequently, when Baeyer applied to these compounds the methods he had evolved in his study of the hydrophthalic acids, he cleared up many points.

It is often assumed that gifted men do their most original work in their youth; and that their creative ability lessens in their later years. But numerous examples could be cited in contradiction, and Baeyer was one of those who even when past sixty was opening new fields. At the age of sixty-six he made his remarkable studies of peroxides and peracids, in



BUST OF BAEYER BY A. v. HILDEBRAND
This bronze is in the library of the chemical laboratory at Munich. It was made in honor of Baeyer's seventieth birthday.

BAEYER MEMORIAL, CHEMISCHES INSTITUT, MUNICH

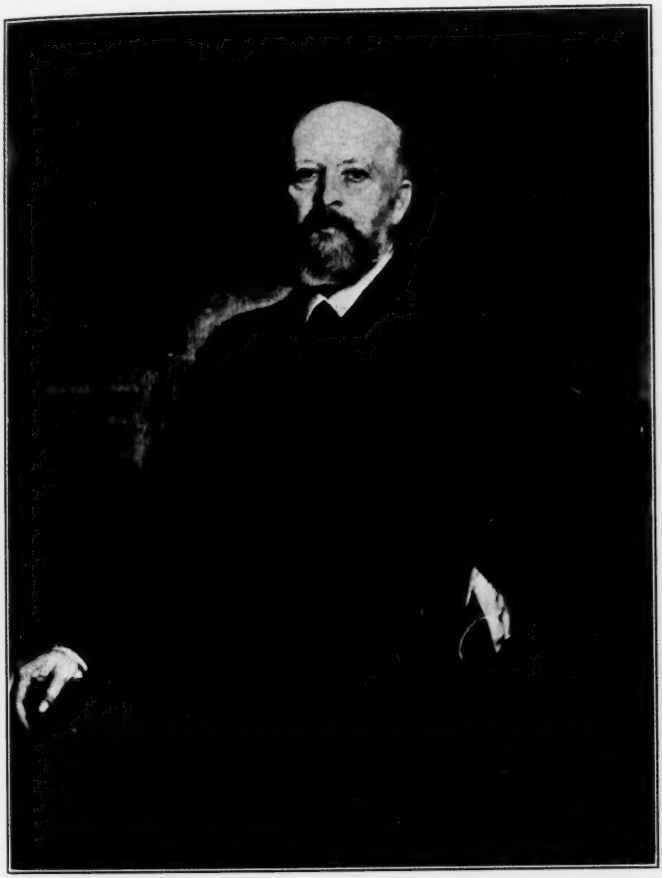
This statue, at the entrance of the Munich Laboratory, was made by Hahn and cast by von Miller in Munich. It is a contribution from the German dye industry, but more particularly from the Interessengemeinschaft der Farbenfabriken. It was unveiled on October 20, 1922. On this occasion, Willstätter, a pupil of Baeyer and his successor in Munich, spoke of Baeyer's services to organic chemistry and to the dye industry. Duisberg, also a pupil of Baeyer, spoke as representative of the dye industry and formally presented the statue to the Academy of Sciences at Munich, whose president, von Seeliger, delivered the address of acceptance. Lepsius spoke on behalf of the German Chemical Society.

which he showed that oxygen may exhibit basic properties not only in certain types of organic compounds but in all varieties of combination. In connection with this work, the question arose as to the origin of color during the reactions of organic compounds and this led him to make certain speculations relative to the basic nature of carbon and to try to express this in structural formulas. His experiments along these lines which involved triphenylmethyl and the triphenylmethane derivatives, etc., initiated a new era. Not until he was more than seventy-five did his creative ability flag.[6]

It is obvious that Baeyer's work had a far-reaching influence on the chemical technology of organic dyes, etc. Without devoting himself directly to the technical realization of his syntheses, his scientific activity nevertheless resulted in important branches of industry. He thereby made significant contributions to Germany's economic welfare.

Baeyer's services as a teacher deserve special recognition. During the

[6] In 1905, Baeyer's pupils honored the master's birthday by publishing *"Gesammelte Werke."* The two large volumes of reprints of papers from his pen and laboratory comprise more than 2100 pages. This also contains his autobiography.



PORTRAIT OF BAEYER BY LENBACH
This portrait in oils hangs in the Pinakothek Gallery in Munich.

seventies he became the successor of Liebig, who, as is well known, founded the first great German school of chemistry. Baeyer's success in continuing this movement was so great that in time almost half the important professorships in Germany and many in foreign countries were filled by his pupils, not to mention those who had been successful in chemical industry. But his methods of teaching were not brilliant as contrasted with those of other professors. His lectures were simple, they were not adorned by rhetorical flights of eloquence, but their content and his clarity of presentation were unexcelled. However, his personal pupils were developed

far more in the laboratory than in the lecture hall. He stressed the importance of training young chemists to think independently. Although many another teacher would, as a matter of course, immediately interpret from the fullness of his knowledge a new result obtained by a pupil, Baeyer seldom did this. He preferred to discuss all the possible explanations and although he, of course, probably knew the correct solution, he led the student to the proper interpretation of the findings.

Baeyer was no theorist as, for instance, was Kekulé. The caricature on page 1240 depicts Kekulé as master of all organic chemistry by reason of his theories. Baeyer always emphasized experiment rather than theory. "I have not planned my experiments to see whether I am right, but rather to determine how the compounds behave." His theoretical speculations should be judged from this standpoint. His fruitful hypotheses and theories were conceived to explain the observed behavior of materials.

Baeyer was a large, good-looking man, with blue eyes and intellectual features. His distinctive personality impressed itself on every gathering and lent weight to his speech. His amiability, knowledge, and originality made him an exceptional figure. His life was simple as became a great scholar, although he was the recipient of every honor that could come to a man of science. He was Nobel prizeman in 1905. Two of the most eminent German artists, Franz Lenbach and Adolf Hildebrand, have produced particularly effective delineations of his appearance. The portrait in oils by Lenbach occupies a prominent place in the new Pinakothek in Munich, and the bronze bust by Hildebrand is also exhibited in that city. The statue of Baeyer near the entrance of the Staatslaboratorium, the scene of most of his labors and achievements, serves as a permanent memorial.

As a man who knew the art of living, Baeyer regularly alternated work and recreation. In Munich, he entertained freely, not only scientists but literary folk. He also maintained a country home at Starnberg near Munich to which he invited friends and colleagues.

His intellect was clear to the very last of his long life. He died after only a brief illness on September 5, 1917, in his eighty-second year. He was buried in the beautiful Waldfriedhof near Munich where a stone marks his grave.

MY STUDENT DAYS IN GERMANY—A CORRECTION ON BUNSEN

Dr. L. W. McCay, author of the article "My Student Days in Germany," which appeared in the May, 1930, issue of THIS JOURNAL, has called our attention to a mistake in the date of Bunsen's death. The first sentence of the first paragraph beginning on page 1099 of that article should read: "Bunsen retired in 1889, and died ten years later on August 16, 1899, at the ripe age of 88, etc."

EXPERIMENTAL MANIPULATION OF GASES FROM CYLINDERS

HAROLD SIMMONS BOOTH, WESTERN RESERVE UNIVERSITY, CLEVELAND, OHIO

In the past chemists have had to generate gases as they needed them. This has deterred many chemists from carrying on studies or, at least, has delayed their work seriously. There are now available, compressed in cylinders, almost all the common gases, making it unnecessary for the chemist to waste his time in generating them. These gases are generally much purer than the chemist would obtain if he prepared them himself. This speeds research in a remarkable fashion, particularly if the chemist is fully acquainted with the methods of using compressed gases and their many possibilities. To this end it has seemed worthwhile to explain the methods by which gases in cylinders may be used most conveniently.

Cylinders and Accessories

The gases are shipped in seven sizes of cylinders; the size to be selected depends not only upon the quantity to be used but also upon convenience in using the gas. The novice at using compressed gases may be helped in choosing the most suitable size cylinder of gas by the table showing the diameter, height, and actual capacity of the various styles of cylinders. The amount of gas contained in the cylinders will vary with the nature of the gas and according to government regulations for each gas, so that no general statement for all gases can be made.

Table of Cylinder Sizes

	Style B	*Style C*	*Style D*	*Style E*	*Style F*	*Style G*	*Style H*
Diameter	$3^1/_4$″	$4^1/_8$″	$4^1/_2$″	$4^1/_2$″	$5^1/_2$″	$8^1/_2$″	9″
Height	16″	18″	20″	29″	55″	55″	55″
Actual capacity, cubic inches	90	142	177	288	930	2380	2660
Actual capacity, cubic centimeters	1474	2326	2900	4723	15252	39032	43624

For usual laboratory work the *Style B* cylinder is most convenient. These cylinders are made of special steel and are standard cylinders complying in every respect with the requirements of the Interstate Commerce Commission. The valves are specially designed to prevent leakage and are equipped with safety devices approved by the Bureau of Explosives, representing the Interstate Commerce Commission.

Large ammonia cylinders are commonly furnished with siphon valves as shown in Figure 1.

Small cylinders such as *Styles B, C, D,* and *E* are equipped with a valve with a small hole outlet (see Figure 2), while larger cylinders are equipped with a threaded nipple, left-handed for the combustible gases, hydrogen and ethylene, and right-handed for all other gases (see Figure 3).

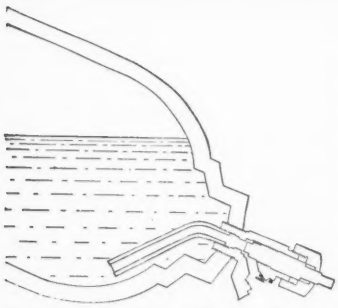


FIGURE 1.—AMMONIA SIPHON VALVES

To obtain the gases from the cylinders, they must be provided with couplings by which connections may be made to tubing. In order to simplify the use of these gases, standard interchangeable unit parts for various connecting and regulating combinations have been devised. The full page of drawings (Figures 4*A*, etc.) shows several unit parts which may be combined in many different ways. The use of cone joints insures gas-tight connections and eliminates the necessity for washers.

Where delicate control of the gas is not essential, it is perfectly satisfactory to clamp a simple yoke with hose connection (see Figure 4*A*) onto the valves of cylinders of *B*, *C*, *D*, and *E* types, using a washer to insure a gas-tight connection. For cylinders *F*, *G*, and *H* it is necessary to screw onto the cylinder the adapter 4*C* and then the nipple 4*D*.

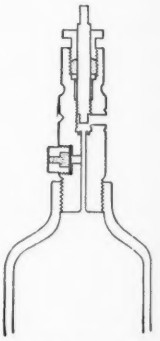


FIGURE 2.—VALVES ON CYLINDERS *B*, *C*, *D*, AND *E*

However, in most cases it is not desirable that the gas issue from the cylinder at high speed. To control the rate of flow delicately it is advisable that an auxiliary needle valve (4*F*) be attached to a threaded yoke (4*B*), clamped on the cylinder valve instead of the simple yoke 4*A*. In the case of the larger cylinders equipped with threaded nipples the adapter 4*C* must first be screwed on and then the needle valve 4*F*. Such assemblies are shown in Figures 5*A* and 5*B*.

FIGURE 3.—VALVES ON CYLINDERS *F*, *G*, AND *H*

When it is desirable to know the cylinder pressure the connecting unit 4*E* may be interposed as shown in Figures 5*C* and 5*D*. Very often, however, it is desirable to know the pressure in the cylinder and also the pressure at which the gas is being delivered to the apparatus in use. For this purpose, reducing regulators are invaluable. Figure 4*G* shows a reducing regulator carrying both a high-pressure and a low-pressure gage. If desired the regulator can be obtained with plugs in place of the gages or with either high- or low-pressure gages. In order to connect the

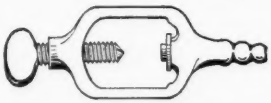


Fig. 4A.

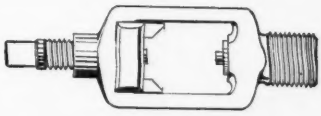


Fig. 4B.

Fig. 4C.

Fig. 4D.

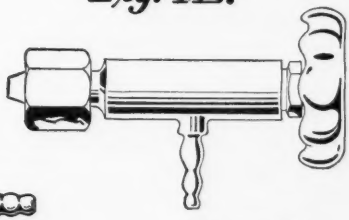


Fig. 4F.

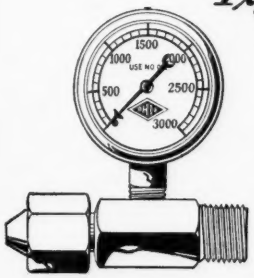


Fig. 4E.

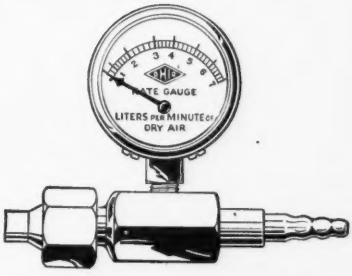


Fig. 4H.

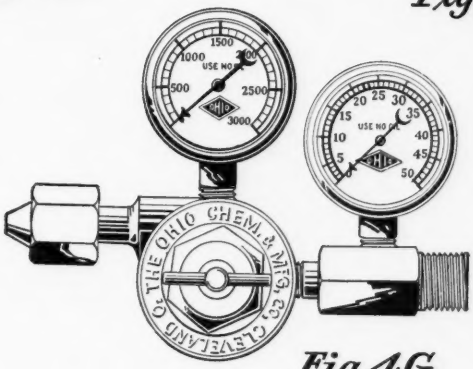


Fig. 4G.

FIGURE 4

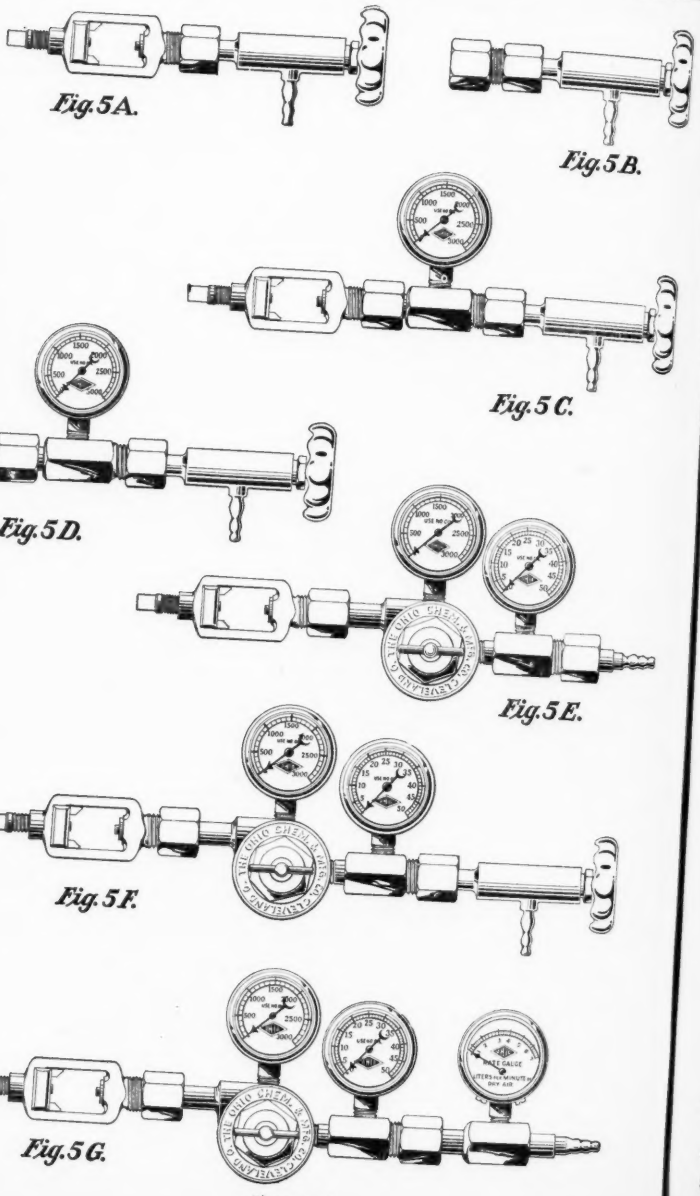


FIGURE 5

reducing regulator to rubber tubing, either the nipple 4*D* may be attached to the regulator or, where even more delicate control is desired, the auxiliary needle valve 4*F*. Such assemblies are shown in Figures 5*E* and 5*F*. On account of the design it is practically impossible to assemble these unit parts in a harmful way. Sometimes it is more practical to have a reducing regulator which will maintain a steady flow of gas at a fixed rate and will show the rate of flow of the gas. Such a regulator must be calibrated for a specific gas since, with a given orifice, the rate of flow is a function of the square root of the density of the gas. Instead of a rate regulator for each gas, the rate gage may be calibrated for a certain gas (carbon dioxide-free, dry air) and the rate of flow of other gases be obtained by multiplying the observed rate by a numerical factor given for each gas. Such a rate regulator is shown in Figure 4*H*, and in a suitable unit assembly in 5*G*. In order to eliminate the danger of assembling the rate gage, 4*H*, so that it might be subjected to high pressure and thus blow up, the connecting cone is fitted with a projection so that it will only fit on unit 4*G*. Since rate regulators are calibrated for zero back pressure, the auxiliary needle valve may not be used, but instead the rate regulator is made with a simple hose nipple. It is apparent that with these unit parts numerous assemblies to suit the particular need can be arranged.

FIGURE 6

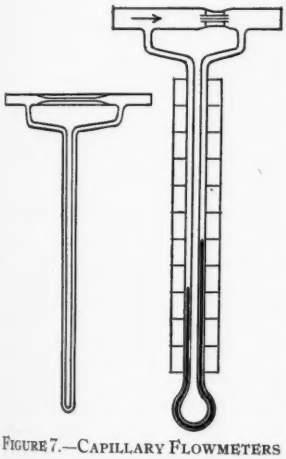


FIGURE 7.—CAPILLARY FLOWMETERS

Rate regulators and unit parts for oxygen must not be used for any other gas or vice versa, because of the danger of oil from the gas getting into the regulator, and then causing a serious explosion when the regulator is again used for oxygen. To prevent this mistake as far as possible, regulators and unit parts for oxygen are finished in polished brass, while for other gases they are nickel plated. Corrosive gases, such as chlorine, phosgene, and ammonia, require fittings of special material. For ammonia, all fittings, couplings, and needle valves, etc., must be made of iron, and copper and brass must be religiously avoided. There is no entirely satisfactory metal for fittings for chlorine and phosgene. Usually bronze is the metal used and valves are fitted

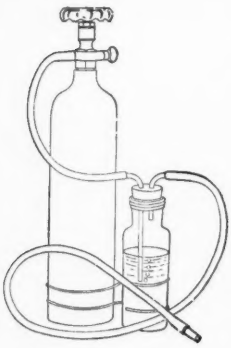


FIGURE 8

with monel stems. The above-mentioned unit parts are not intended for use with corrosive gases.

The Operation and Care of Reducing Regulators

Before attaching the regulator to the full cylinder of gas always try the cylinder valve, by opening it a trifle and then closing it quickly, to see that it does not stick. Thus, any foreign matter in the cylinder valve will be forced out. When attaching the regulator to the cylinder, be sure to place one washer in the coupling adapters 4*C* or yoke 4*B*. These washers are provided with every cylinder. Attach regulator securely to the adapter or yoke, first making certain that the regulator is intended for use with the kind of gas contained in the cylinder. On account of danger of explosion a reducing regulator used for any other gas must not be used for oxygen or other oxidizing gases. Conversely a reducing regulator for oxygen must not be used for other gases.

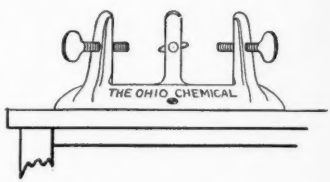


FIGURE 9.—CYLINDER FOOT RING

If a user decided to insert some specially made fitting into a high-pressure oxygen line the fitting should be thoroughly extracted with carbon tetrachloride or ether until the extraction liquid leaves no residue on evaporation in a watch glass. It should then be thoroughly freed from solvent by passing dry air through it. Failure to do this resulted in a serious fire which actually burned the brass fittings and was extinguished with difficulty.

Before turning on the main gas valve of the cylinder, loosen the regulator valve adjusting screw by turning it in a counter-clockwise direction. Then open the valve on the cylinder itself slowly and completely. The gage indicating the cylinder pressure will then operate while the low-pressure gage should show zero pressure. Then turn the adjusting screw very slowly clockwise until the hand on the low-pressure gage registers the desired pressure. When through using the gas it is always advis-

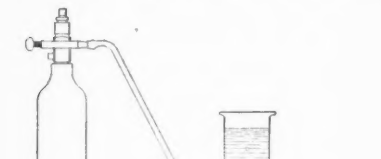


FIGURE 10.—COLLECTING GASES FROM CYLINDERS

able to close the cylinder valve and turn the regulator screw counter-clockwise until loose.

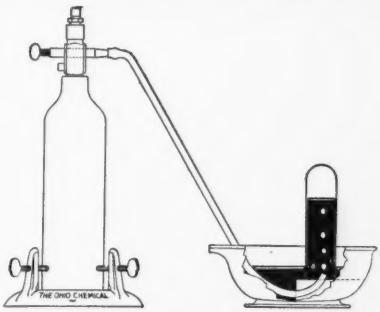


FIGURE 11.—COLLECTING WATER-SOLUBLE GASES

Controlling Rate of Flow of Gases

Sometimes it is desirable to know the rate at which gases are being used or to be able to adjust the regulator so that a definite flow of gas per minute will result. Such a device is shown in Figures 4*H* and 5*G*. Figure 6 illustrates an apparatus for controlling the amount of gas released per minute for the use of ethylene in ripening fruits.

For small rates of flow a capillary flowmeter, such as those shown in Figure 7 is useful. This must be calibrated before using. For this purpose attach a gas meter at the outlet, pass the gas through the capillary, noting rate (meter reading and time) and difference in level in manometer arms. Repeat for several rates and then plot a curve of manometer pressure against rate. For accurate work it should be calibrated with the same gas with which it is to be used later. Visual control of the flow of gas may be accomplished with the aid of a bubbling bottle shown in Figure 8. In this case, for convenience, the bubble bottle is clamped directly to the cylinder. However, this is not necessary.

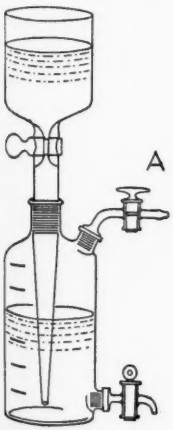


FIGURE 12.—GAS RESERVOIR

Sometimes in the laboratory it is convenient to set a small cylinder upon the laboratory table. A foot ring such as shown in Figure 9 will adequately support the cylinder and prevent it from falling over. This may be screwed permanently in place on the table top.

The Collection of Gas in the Gaseous State from Cylinders for Class Demonstration or Experimentation

The simplest method of collecting gases from cylinders is to bubble the gas up into an inverted glass jar filled with water in a pneumatic trough, such as shown in Figure 10. When it is desired to remove the glass jar containing the gas, a flat glass plate is slipped under the mouth of the jar and it

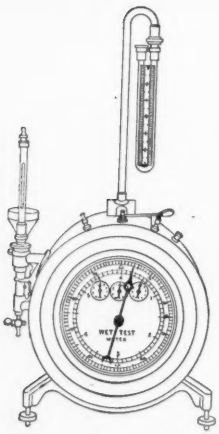


FIGURE 13.—WET GAS METER

then may be removed from the pneumatic trough. Certain gases, however, are so soluble in water or react so quickly with it that it is necessary to collect them over oil or mercury. A suitable mercury trough made of porcelain, as shown in Figure 11, is available.

Where it is desired to collect a rather large quantity of the gas for a continuous demonstration, it is better to use a reservoir of the type shown in Figure 12. This reservoir is filled with water or, in the case of chlorine, with a saturated salt solution to decrease the solubility of chlorine, and then the gas is forced in through stopcock *A*. The liquid then rises in the funnel and stopcock *A* should then be closed and the cylinder disconnected. The gas in the reservoir is now under the slight pressure of the column of liquid in the funnel and may be conveniently drawn off as desired through stopcock *A*. By calibrating the reservoir with horizontal lines it is possible to measure roughly the amount of gas used. When the gas is stored in such a fashion over water it becomes saturated with it, and for many purposes would need drying before use. Drying agents are discussed on pages 1258–9.

For certain class demonstrations, *i. e.*, the demonstration of the formation of SO_3 from SO_2, or for the reduction of copper oxide to copper by hydrogen, it is more convenient to have a continuous flow. In such cases it is advisable to control the flow by a reducing regulator or by a rate regulator, such as previously described. For accurate measurement of the quantity of gas used, a gas meter such as the simple one shown in Figure 13 should be interposed in the system, either before or after the device through which the gas is passing. If placed before the device, it must be remembered that the gas meter is partly filled with water and that the gas which has flowed through it will be moist. It is therefore usually advisable to place the gas meter in the outlet side of whatever device the gas is being passed through.

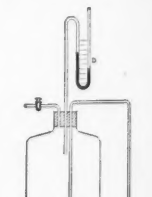


FIGURE 14.—GASOMETER

Instead of a gas meter the arrangement, as shown in Figure 14, consisting of a large five- or ten-liter bottle, will serve very satisfactorily to measure small volumes. The gas passes into the bottle, previously filled with water, through the upper stopcock and collects in the upper part of the bottle. The water thus

displaced travels out the siphon tube and is accurately measured here by weighing or by a graduated cylinder as it flows into it. The pressure of the gas is shown on the small manometer D and the volume of the gas must be corrected to standard pressure, keeping in mind that the pressure of the gas is equal to the atmospheric pressure corrected for the pressure recorded on the manometer. The pressure must also be corrected for the aqueous tension at the temperature of the experiment. When these precautions are taken this becomes a fairly accurate method of measuring gas volumes.

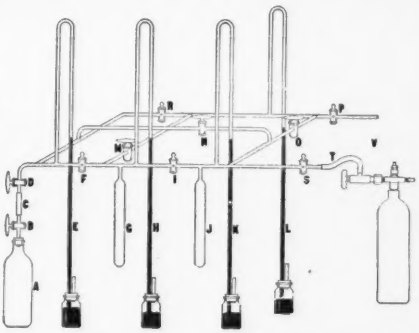


FIGURE 15.—FRACTIONATING APPARATUS ARRANGED FOR TAKING SAMPLES OF FRACTIONS AT A

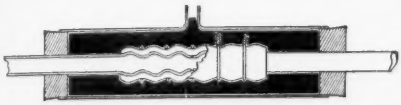


FIGURE 16.—MERCURY SEAL

How to Handle Gases for Use in Precise Research

For precise research an all-glass apparatus is usually used, because rubber connections are sure to leak to a certain extent unless each connection is mercury sealed. This latter procedure would be too cumbersome in a large apparatus, so it is customary to fuse the glass tubing, with a hand torch, into the required shape or design. Such an all-glass apparatus is shown in Figure 15. The glass apparatus is connected to the needle valve by a heavy rubber tubing, which should either be completely covered with a medium hard de Khotinsky cement, or mercury sealed as shown in Figure 16. While gases supplied are quite pure as commercial articles go, it is rarely feasible to make them industrially pure enough for the more precise research work. The chemist may desire to purify them further, *i. e.*, for accurate studies such as the determination of the physical constants of gases. The most practical method of purification is the fractional distillation of the liquid gas at low pressure after chemical treatment has removed such other impurities as are amenable to this treatment.

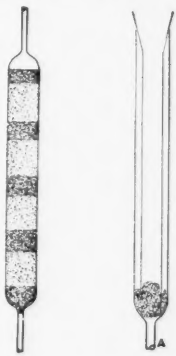


FIGURE 17 FIGURE 18
TYPICAL $CaCl_2$ DRYING TUBES

Drying and Absorption Tubes

Before fractionation gases should be dried by passing them over a suitable drying agent in a tube, such as shown in Figure 17. To make such a tube, a piece of glass tubing 2–3 cm. in diameter is drawn down at one end and a small tube is sealed on (see Figure 18). Before filling the tube it should be dried by a Bunsen flame while dry air is passing through it. A loose wad of dried glass wool is then inserted and pushed down to the constriction. A dried funnel tube (made by flanging out one end of a tube which will fit into the drying tube) is inserted and the drying agent

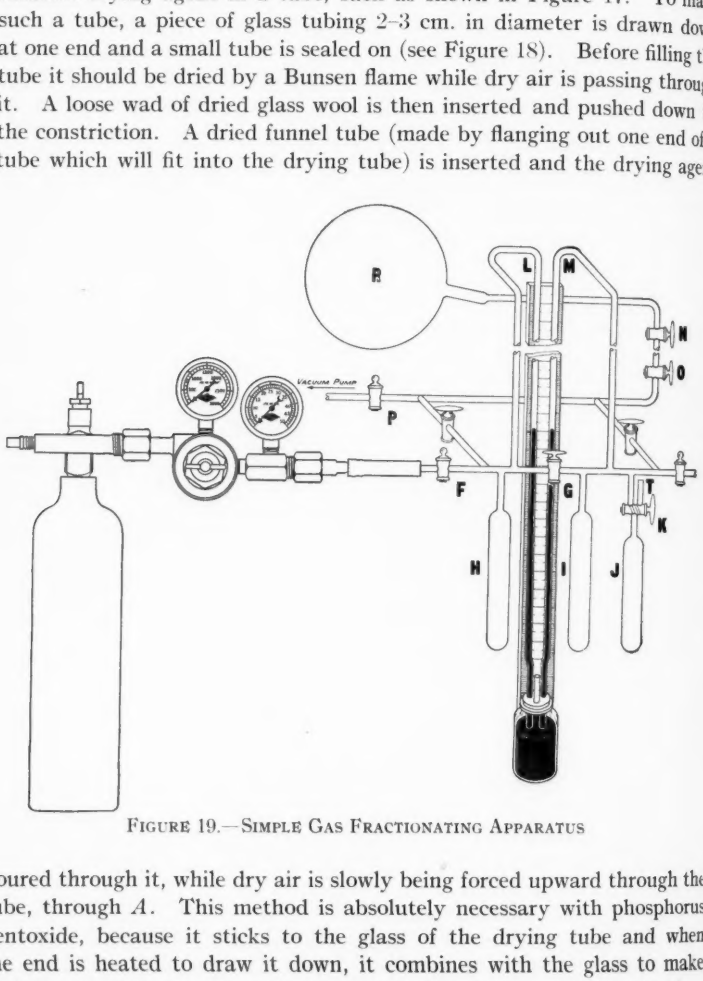


FIGURE 19.—SIMPLE GAS FRACTIONATING APPARATUS

poured through it, while dry air is slowly being forced upward through the tube, through *A*. This method is absolutely necessary with phosphorus pentoxide, because it sticks to the glass of the drying tube and when the end is heated to draw it down, it combines with the glass to make an infusible mixture. In order to prevent channelling, it is best to place the drying agent in several sections separated by glass wool. Such reagent-filled tubes should always be used in the horizontal position, since in the vertical position they are apt to clog. For acid or neutral gases, and such as do not react with it, phosphorus pentoxide, free from phos-

phorus trioxide or red phosphorus, should be used. For basic gases such as ammonia, or for neutral gases, lump porous barium oxide[1] is an excellent drying agent. For neutral gases it is much more convenient to use than phosphorus pentoxide. Carbon dioxide as an impurity may readily be removed by passing the gas through a tube containing moist solid potassium hydroxide in lumps the size of a pea before drying the gas. Of course, this cannot be used in the presence of other acid gases which would react with it. Hydrogen may be freed from the last traces of oxygen either by passing the gas over heated copper or by passing it through a U-tube filled with palladinized asbestos maintained at the temperature of boiling water.

FIGURE 20.—ARRANGEMENT FOR COLLECTING CARBON DIOXIDE SNOW

Fractionation

After the preliminary chemical treatment, the gas may be liquefied and fractionated. The choice of a refrigerant for this purpose depends upon the boiling point of the gas to be liquefied. Liquid ammonia boiling at —33.4°C. is an excellent refrigerant for gases boiling above —25°C. and solid carbon dioxide-acetone mixtures are excellent refrigerants for gases boiling above —75°C. For lower temperatures, liquid air is necessary.

With reference to the apparatus shown in Figure 19, the operations of fractionation are carried out as follows: the fractionating apparatus is first carefully dried by alternately evacuating it with a vacuum pump (if a water pump is used, a drying tube must be placed between pump and apparatus to prevent diffusion of moisture back into the apparatus) and filling with dry air obtained by allowing the air from the room to enter the apparatus slowly through drying tubes. Twelve such washings with dry air are usually sufficient to remove water from the inside walls of the apparatus. Of course, it must be remembered that water clings tenaciously to glass surfaces and the only way all of the water can be removed in a short time is by heating the surface of the tube while drying. However, this is unnecessary for most work. The vacuum flask (Dewar

[1] Booth and McIntyre, "Barium Oxide as a Desiccant," *Ind. Eng. Chem., Analyt. Ed.*, **2**, 12 (1930).

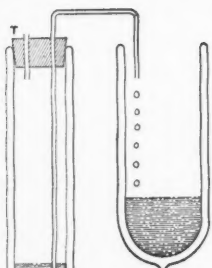


FIGURE 21.—TRANSFERRING LIQUID GASES

flask) is half filled with the refrigerant and brought up so as to surround the liquefying bulb *H*. The stopcock *F* and the reducing regulator are slowly opened and the gas allowed to condense in the tube *H*. When the tube is about half filled with liquid gas, the cylinder valve, reducing regulator, and stopcock should be closed in the order named.

We are now ready to fractionate the liquid gas. For this purpose the Dewar containing the refrigerant is removed and placed so as to cool the other liquefying bulb *I*. Then the gas in tube *H* is allowed to warm until it begins to boil and the first gas is allowed to boil off and is pumped off through the vacuum line through *P*. Then, when one or two hundred cc. of the gas have been rejected in this fashion, the stopcock to the vacuum line is closed and stopcock *G* is slowly opened, permitting the gas to boil from tube *H* into tube *I*. The rate of flow can be adjusted by opening stopcock *G* only slightly and then adjusting the stopcock while watching the difference in pressure in manometers *L* and *M*. The mercury-filled manometers are of the safety type: if the pressure gets too high in the system the gas can escape by bubbling up through the mercury in the well. Always have such safety manometers in a system in which liquefied gases are being handled, or gases generated.

When only a small amount of liquid gas is left in the tube *H*, stopcock *G* is closed and this residual gas pumped out by the vacuum pump and rejected. We thus have effected the separation of the middle fraction of the gas. This operation is then repeated, the contents recondensed into the original tube *H*, again rejecting the first and last fractions.

It is difficult to advise the worker on the number of fractionations necessary to secure a pure product. That depends on the difference in boiling points of the impurities and of the pure gas itself, and as to whether or not the impurity is very soluble in the liquid gas. It is obvious that it is more difficult to separate impurities if the boiling points of the impurity and of the gas itself are close and if the im-

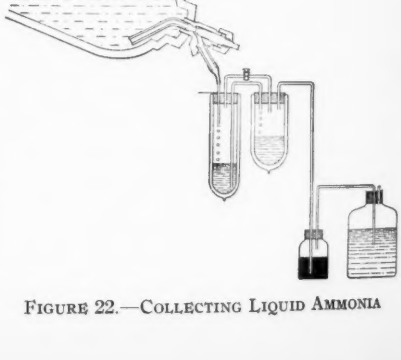


FIGURE 22.—COLLECTING LIQUID AMMONIA

purity is soluble to any great extent in the liquid gas. Usually six fractionations will yield a satisfactorily pure gas, but the writer has found it necessary in some cases to fractionate twenty-five to thirty times before the desired purity was obtained.[2] The gas then may be stored in a large bulb *R*, Figure 19, until desired. By condensing gas in tube *J* samples for gas analysis can be taken by turning *K* so as to connect the side tube with the buret. Figure 15 shows an arrangement for taking samples (at *A*) of the impurities which are fractionating off from the gas being studied.

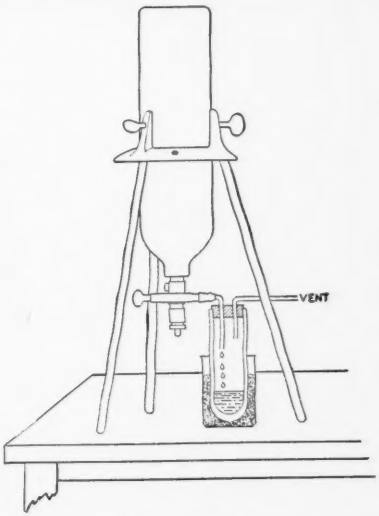


FIGURE 23.—ARRANGEMENT FOR OBTAINING LIQUID GASES

Obtaining Liquid Gases

Gases whose critical temperatures are above room temperature or which may be readily cooled in the cylinder below the critical temperature can be easily obtained in the liquid state for demonstration. The cylinder should be set on the ring and tripod (see Figure 23), so that the liquid in the cylinder will fill the valve end. To the valve should be connected a yoke 4*A*, or 4*C* and 4*D* for large cylinders (not a reducing valve). This adapter should then be connected by a stout rubber tube to a short glass tube running through a two-hole rubber stopper, halfway to the bottom of the vacuum flask. From the hole in the stopper lead away a rubber tube to the vent. Open the cylinder valve slowly and in a few moments, when the liquid gas has cooled the rubber and glass connections, liquid gas will begin to collect in the vacuum flask. The liquid gas may then be transferred to another vacuum flask, as shown in Figure 21, by placing the finger over the short open tube *T*, whereupon the pressure of the boiling liquid gas will force the liquid over into the second container. Do not pour liquefied gases from a vacuum flask; the sudden chilling of the rim may cause the vacuum flask to crack and implode. An arrangement for combining in one apparatus both these devices is shown in Figure 22 for collecting liquid am-

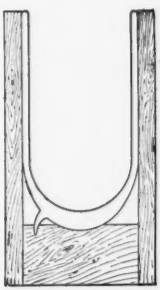


FIGURE 24

[2] Germann and Booth, *J. Phys. Chem.*, **21**, 92 (1917); **30**, 369 (1926).

monia.[3] If the gas is soluble in water, such as ammonia, it is better to bubble it into water to absorb it. In order to prevent the water backing up it is advisable to place a trap, such as that shown in Figure 22, partly filled with mercury, between the water and the collector of the liquid gas.

Solid Gases

Since the triple point for carbon dioxide is 5.2 atmospheres it cannot exist at atmospheric pressure as a liquid. When the pressure on the liquid gas is released by opening the valve on the cylinder (provided the cylinder is placed in the position shown in Figure 21) some of the liquid carbon dioxide escapes, and boils rapidly, thus absorbing heat from the rest. This causes the rest to solidify. The easiest method of collecting it is shown in Figure 21. A nipple with ferrule to which is fitted a special chamois bag (see Figure 24) is screwed onto the valve of large cylinders or onto an adapter with small cylinders. Chamois gives a greater yield of solid CO_2 than canvas or other material. The valve is then slowly opened and closed (to prevent clogging the valve seat by solid particles of carbon dioxide) and the solid carbon dioxide collects in the bag. By releasing the thumbscrew the solid gas can be dumped out into a large beaker or, better still, a large wide-mouthed vacuum flask, such as shown in Figure 24, where it will keep much longer. The rush of gases from the pipe often causes the accumulation of static charges which are painfully discharged into the body of the operator. This can be alleviated, if not entirely eliminated, by grounding the cylinder to the water pipe. Solid carbon dioxide should not be handled with the fingers as severe blisters from freezing are apt to result. It is better to handle it with a large spoon, preferably of some non-conducting material like Bakelite.

Freezing Mixtures with Carbon Dioxide

When solid carbon dioxide is added to acetone or ether, the temperature of the liquid is lowered, some of the carbon dioxide dissolves and some bubbles out. Finally, when the temperature is low enough, the solid carbon dioxide remains as a mush in the acetone or ether. With such a mixture a temperature as low as —77°C. can be obtained and such mixtures make excellent refrigerating agents.

Acknowledgments

The writer is indebted to the Ohio Chemical and Manufacturing Co., of Cleveland, for their kindness in lending the cuts used to illustrate this article and in furnishing data.

[3] See also Johnson and Fernelius, "Liquid Ammonia as a Solvent and the Ammonia System of Compounds. IV," THIS JOURNAL, **6**, 441–4 (Mar., 1929).

PRINTING PROCESSES. II. SURFACE OR PLANOGRAPHIC PROCESSES*

SAUL B. ARENSON, UNIVERSITY OF CINCINNATI, CINCINNATI, OHIO

Lithography

The outstanding example of printing from a plane surface is lithography. As the name indicates, originally all lithographs were printed from stone, although modern practice involves the use of metal plates as substitutes. Those interested in the history of this subject will find an excellent review in "Printing Ink" by F. W. Wiborg.[3] Suffice it to say here that Senefelder in 1796 noted that a smooth-grained Bavarian limestone would take water or grease, but only one in any particular area. That is, if the surface was coated with water, it would repel greasy ink, or if marked with that ink first, would not permit water to adhere. He made use of that fact in this way: he wrote on the grained surface with a greasy crayon, and dampened the remainder. Then he inked the entire surface of the stone with a greasy (non-aqueous) ink, applied from a roller. The ink was attracted to the crayon marks but of course would not adhere to the moistened areas. An impression could be made by placing a sheet of dampened paper on the stone and running the stone and paper through a press similar to the one mentioned in the previous article. This stone could be redampened, reinked, and thus hundreds of impressions taken.

Courtesy Commercial Engraving Publishing Co.

FIGURE 4.—ENGRAVING ON STONE

Throughout all the elaborations and advancements to be mentioned in the lithographic processes to follow, it will be noted that the principle of the process is still the same, namely, the *non-wettability* of greases by water and of water by greases. It is not a case of filling in the hollows of a plate with ink, to be transferred to paper, as in engraving processes, nor printing from an elevated surface, as in type printing, but actually printing from a plane surface.

This discovery of Senefelder, in making duplicates of his mother's laun-

* Part I of this series of articles appeared in THIS JOURNAL, **7**, 1028–36 (May, 1930). Part III will appear in the July number.

[3] Published by Harper & Bros., New York City, **1926**, 199 pp.

dry lists, was the starting point in this great industry and art where, in the United States alone, 200,000 tons of paper are used annually in making one hundred million dollars worth of finished lithographs.

Naturally there were many difficulties to be overcome. The stone was somewhat bulky, for it had to be used in three-inch thicknesses. (See Figure 4.) It was expensive and took up too much storage space. The chief type of work which could be done was line drawing, although it must be admitted that the crayon lithographs showed graduation in tones, having a fine stippled appearance, due to the rough surface of the stone. The design was usually drawn on the stone by hand, of course in reverse.

Offset Blankets

One of the important improvements was the addition of the rubber blanket, thus making the process an offset one. That is, the ink was not printed directly onto the paper from the stone, but was actually transferred from the stone onto the blanket, and from the blanket to the paper. The perfecting of this process permitted the original sketch to be drawn on the stone as it would appear on the paper, and not in reverse, since the blanket did the reversing. That, however, was merely a minor point. More important still was the fact that the plate would come in contact with a resilient rubber blanket, taking off the ink in transferring it to the paper. The resiliency of the blanket also would make up for any inequality in the thickness of the paper, an important item, and increase the life of the plate considerably.

Because, even with the improvements afforded by the blanket, the process was slow (800 impressions per hour maximum) discontinuous, and for many other reasons, efforts were made to use metal printing plates as substitutes for the stone. If a metal could be found which would be sensitive to water and ink as the stone was, then this plate could be shaped in the form of a cylinder, put on a rotary press, and a continuous printing process developed.

Metal Plate Lithography

Neither copper nor iron can be used. Copper is too dark, not permitting the artist to see corrections or additions easily. Furthermore, it becomes greasy all over. In other words, it will take greasy ink uniformly all over the whole plate, regardless of whether parts of the plate are wet with ink or water. It lacks that essential characteristic which Senefelder noticed in his stone. Nor is iron any more sensitive. The two metals in common use are aluminum and zinc. At present the aluminum plate costs about five times as much as the zinc one of the same size, but since the aluminum is stiffer and will not buckle, and is somewhat lighter in color, permitting greater contrast between the ink and the bare metal, the use of aluminum

plates is becoming more popular. However zinc is still the more common, for it has better bending qualities and does not break so readily when clamped on the cylinder of the press. An average of 50,000 impressions can be made from either before the plate is worthless and must be regrained and redesigned, although runs of 150,000 are not uncommon. A plate can be regrained about eight times before its usefulness is gone.

Let us follow a plate through the various steps in its preparation for the press. It is made of practically pure metal, annealed after rolling to remove strains and imperfections, then cut into sheets in size from 15″ × 18″ to 44″ × 64″, usually of 4- to 12-gage (0.6 mm. to 2.7 mm.) thickness.

The sheet is first cleaned with dilute acid and sometimes washed with an

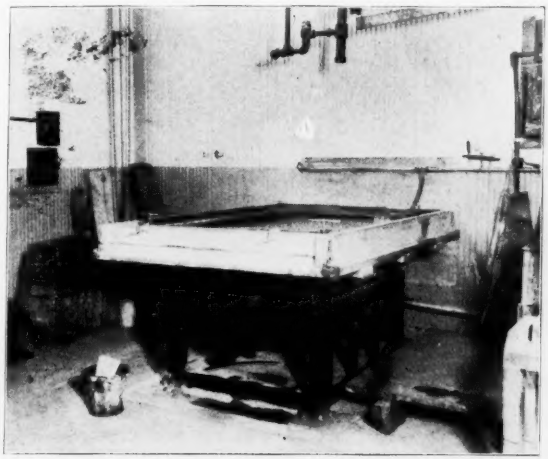


FIGURE 5.—GRAINING MACHINE FOR PRODUCING THE NECESSARY MATT SURFACE ON METAL LITHOGRAPHIC PLATES

organic solvent to remove traces of grease. It is then grained by placing it horizontally in a graining machine (see Figure 5) and covered with a single layer of glass or steel balls, usually about an inch in diameter. Finally a watery paste of powdered sand, pumice, or emery is added. As the machine vibrates in a horizontal, circular motion, the abrasive gets in between the balls and the plate and gouges out microscopic bits of metal plate. A drop of water placed on a polished metal surface might retain its shape, but on a grained, rough surface would flow and more uniformly wet the surface. In other words, the grained metal plate has a somewhat porous surface, which is one prerequisite required in a lithographic process.

On account of the enormously increased surface, due to the graining process, the plate is more readily oxidized, forming a layer of oxide which

does not selectively absorb water or ink. The plate is therefore coated with a "counter etch" to minimize this oxidation. The process is to wash the zinc plate for a half minute with a solution containing from a quarter to a half-ounce hydrochloric acid per gallon of water. A solution of 4 oz. acetic acid and 1 oz. of nitric acid, per gallon, is used for aluminum plates. The cleaned plate is usually dried rapidly.

Now the plate has all the good qualities of the stone. For example, a design can be traced by means of Tusche and then "etched." Here the term "etch" does not mean the same as in engraving work, for it has little, if anything, to do with actually biting into the metal. This "etching" decreases the sensitivity of the plate for ink and prevents oxidation. The etching solution always contains gum arabic and phosphoric acid dissolved in water. Sometimes chromic, tartaric, or tannic acids are substituted for part or all of the phosphoric acid. The etching solution is flowed on and dried. When the plate prepared in this way is put on the press, this gummed surface will take water from the moistening roller and refuse ink, while the inked surface will take ink and refuse water.

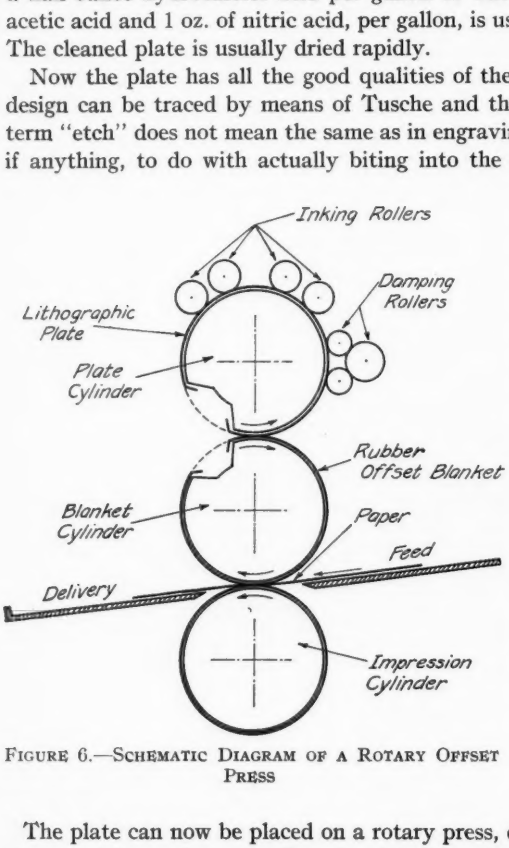


FIGURE 6.—SCHEMATIC DIAGRAM OF A ROTARY OFFSET PRESS

The plate can now be placed on a rotary press, dampened by coming in contact with a moistened roller, then inked by the ink roller. An impression can now be removed by having the inked, moistened plate revolve against a rotating blanket, which transfers the ink to a sheet of paper, and this process repeated thousands of times. (See Figure 6.)

Frequently still, the design is drawn on stone and transferred to the sensitized metal, especially if many copies of the original are to be printed on a single sheet of paper by one operation. For example, the design on the back of a playing card might be drawn on stone and the inked impression transferred, by suitable transfer paper, to the metal plate in 56 different

places so that the plate could print 56 identical copies on a single sheet of paper in one operation. One device for transferring is so clever that the sketch can be transferred quite enlarged or diminished in size, as wanted. It can be seen that another advantage of the transfer process is in making a more permanent record, for if the metal plate is ruined on the press, the artist's work is not lost, for it is permanently placed on stone, from which copies can be transferred to another plate at will.

In case a description is to accompany an illustration the subject matter may be set in type, inked with transfer ink and transferred to its proper place on the plate. The transfer ink from then on acts as the printing image, thus permitting lithographic reproductions.

This transfer paper is thin, strong-sized paper, but not sized with so much rosin that it prevents the penetration of water. The object in having the paper sized is to give it a smoother surface so that each dot and line will stand out perfectly sharp. It furnishes the proper surface to hold the mixture of glycerin and starch with which it is to be coated. One formula which gives an "ever-damp" surface contains one pound glue and 130 oz. glycerin in 130 oz. water to which a few grams of phenol have been added as a preservative. Scotch transfer paper is surfaced with flour, plaster of Paris, glue, gum arabic, gum gamboge, and phenol in water.

However these are transfer methods. If we want to put the image more directly on the plate we may resort to photographic processes called, in general, photolithography.

Photolithography

Let us discuss a simple case first. Suppose we are interested in reproducing a line sketch on paper, say black on white, with no intermediate shades or tones of grey. It might be, for example, a pen and ink sketch. First we photograph the original in the conventional manner. The photographic plate, when developed, is naturally the negative of the original drawing and shows transparent lines on a black background. Next, the metal plate, having been cleaned, grained, and counteretched, is coated with a thin film of bichromate-albumen solution.

A typical formula is:

Egg albumen scales	3 oz.
$(NH_4)_2Cr_2O_7$	1 oz.
H_2O	32 oz.

This plate is whirled to spread the coating uniformly, and dried while whirling, leaving a thin film on the grained plate. Since this film, when dried, is sensitive to light, this operation is carried out in the absence of actinic light.

If the photographic negative is now placed in contact with the sensitive side of the metal plate, and light from the sun's rays, mercury vapor or carbon

arcs allowed to fall through the negative, a chemical reaction will take place only in those portions where the light can strike the bichromate-albumen film. (See Figure 7.) It may be that the bichromate oxidizes the albumen, forming an oxidation product which is very insoluble and attached to the metal mechanically or perhaps some of the dichromate is reduced in

FIGURE 7.—VACUUM PRINTING FRAME AND ARC LAMP USED IN PRODUCING THE IMAGE ON PHOTOLITHOGRAPHIC PLATES

light, forming Cr^{+3}, which in turn forms chromium chromate, which is insoluble, and tans the albumen as it does leather. The chances are that both reactions take place simultaneously. Whatever the explanation, the albumen directly below the clear spaces on the negative will become insoluble in water and not readily removable from the metal plate. Where the light was blocked from coming in contact with the sensitive film, no

such reaction takes place and the albumen can be easily washed away with water. So now, after suitable exposure, the plate is inked all over with a greasy ink and then developed by immersion in water and light abrasion with a wad of cotton. There will remain on the plate lines of hardened albumen corresponding to the original lines on the sketch, and areas of practically bare metal, corresponding to the whites of the drawing. The plate is then etched with gum arabic as previously mentioned and it can now be used on the press. Of course there are niceties in the process, such as building up the image to increase its durability on the press, etc., which cannot be discussed in a brief survey like this.

Halftone Screen

Now let us discuss a modification of this process permitting us to produce lithographically a photograph. This photograph is a continuous-tone print because, although it is in black and white, it has all shades of grey in between these two extremes. Here we have shaded areas, not lines. This type of work could not have been made previous to the discovery of the halftone screen.

FIGURE 8.—HALFTONE SCREEN, GREATLY MAGNIFIED

This screen, which is similar to the one employed in color relief printing and halftone newspaper cuts, is different however from the one mentioned under rotogravure. This one is made of two pieces of glass cemented together. Each one has previously been ruled with a cutting edge in parallel lines in such a way that the distance between lines is equal to the width of the ruling. These depressions are filled with a dark pigment. The two glasses are cemented together so that the lines are at right angles to each other, making a screen in which the area of the openings is equal to $1/4$ the area of the plate. (See Figure 8.) The rulings are uniformly placed 60 to 400 per linear inch.

We now have the necessary halftone screen. The original photograph, which we want to reproduce, is put in a copying camera, and a negative is made photographically. But this screen has been placed in the camera,

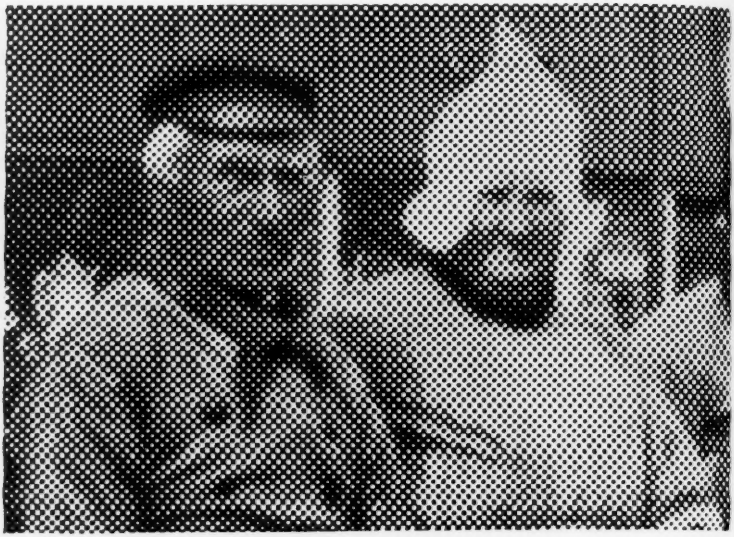


FIGURE 9.—PRINT MADE FROM HALFTONE NEGATIVE
Notice the different sized dots.

too, between the original to be photographed and the photographic plate. The result is that after proper exposure and development, this negative consists of millions of dots of silver of varying diameters. The lighter the area on the original, the more light gets through that particular spot on the screen, and consequently the larger the dot of silver. A regular photographic print, for example, of this halftone negative would resemble the original if held a foot away from the viewer, but under the hand lens would show these individual dots. Note the illustration below.

C. W. Hackleman[4] states that the screen operates as follows:

> The cross lines of the screen intercept the light and each minute square between them acts as a diaphragm through which the light from the camera lens passes to the negative and forms on it in very small compass that part of the image as seen through the lens diaphragm or light opening. The properties of the light are such that while the openings between the lines of a given screen are all of the same size, yet by manipulating the distance of the screen from the plate and the diaphragm, the stronger rays which come from the high lights of the copy spread out and make larger dots in that part of the negative, while those from the dark spots of the picture make an impression upon it that appear as a series of microscopic points. In the print made on the plate from the negative these conditions are reversed and the high lights are represented by

[4] "Commercial Engraving and Printing," Commercial Engraving Publishing Company, Indianapolis, Indiana, revised edition, 1924, p. 252.

the smallest pin points, which grow larger as they blend off into the darker tones and then converge into hollows or openings which decrease in size through the shadows to a solid surface in the blacks.

In this manner the image on the negative is cut by the cross lines of the screen, the size of the small exposed dots corresponding to the ruling of the screen used and the manner in which the light has spread as it reached the negative through the screen. The opaque lines in the screen produce white or transparent dots in the negative, which in turn produce black dots in the print on metal.

This halftone negative is used in the same way that the negative was in the previous process. While placed in intimate contact with the sensitized metal plate, it is exposed to light three to six minutes. Where no light gets through, due to dots of silver on the negative, no tanning of the albumen takes place. The rest of the surface becomes hardened, due to exposure to light through the cleared areas on the photographic plate. The plate is then inked and placed under water where the unexposed albumen dissolves and floats off the excess ink. After "etching" with gum arabic, we now have a printing surface of millions of hardened dots of varying areas. The uninitiated person viewing the results of printing from such a plate will not notice these dots, for where the printing is the darkest, they are very close together and where the print is light, they are very small. But they can be noticed through a hand lens. The result looks like a continuous-tone, but that is due to an optical illusion. (See Figure 9.)

Lithography, How Recognized

Lithography is only one out of many processes using these dots from a halftone screen. However, since in most other processes the ink is transferred from harsh metal dots, by squeezing, the printed image shows these dots having a lighter center and a hard ring on the border. The lithographic dot, coming from a relatively soft printing surface, by squashing, has a darker center, lightening toward the outside, giving each dot a fuzzy appearance and generally giving the finished print a much more pleasing effect to the eye.

Colored Photolithography

Suppose that this time we want to reproduce in their natural colors, lithographically, a vase filled with flowers. If the job is to be a relatively inexpensive and simple one, the chances are that it will be printed in four colors—yellow, red, blue, and black.

This necessitates, of course, the printing of the sheet four times with four different colors from plates made particularly for each color. Again we depend on an optical illusion, for although we use the three primary colors we can get almost any shade or hue desired. That is because where in certain areas we have small dots of red ink interposed among similar

yellow dots, an orange results to the naked eye. Furthermore, the orange will be of all different shades, depending on the relative sizes of the various dots. In a similar manner we can get green, purple, and black. Although theoretically the three primary colors will give black, that color is printed from black ink, otherwise the color would be grey due to too much admixture with white.

With this preliminary discussion, we are now ready to reproduce in colors. We first photograph the subject, four times, in the conventional manner, except that we use a ray filter between the lens of the camera and the subject. These ray filters are merely colored glasses or films, which cut out light in certain portions of the spectrum. For the negative to be eventually used in the printing of the yellow ink, a blue filter is used. A red filter is used for the blue plate, a green one for the red plate, and either orange, green, or pale yellow for the black plate. These four photographs must be taken in precisely the same manner, same focus, same distance between lens and subject, the color of the filter being the only variable.

A contact positive is made of each negative in the ordinary manner. This is a continuous-tone or color-correction positive. Next a halftone negative is made of this positive, employing the screen. The angle at which the screen is placed depends on the color of the ink to be printed from the printing plate resulting from this negative. Customary angles are 45° for the blue, 30° for the yellow, and 60° for the red. This is done to minimize the formation of an unwanted moiré pattern and to prevent too many dots from being superimposed and losing their identity.

So by the process already discussed, a metal printing plate is made for each color. Each is properly inked and the four colors printed consecutively on the same area of the paper in proper register. The order is usually the yellow first and the black last. The ordinary yellow lithographic ink is opaque, which means that if it were printed over a transparent ink like the red it might blot out the red altogether, while if the order were reversed an orange would result.

The result of this type of graphic reproduction is a very soft blending of colors. This is of course due to the type of printing surface. Furthermore it must not be forgotten that the ink was removed from a hardened, somewhat gelatinous albumen surface, transferred to a rubber blanket and then onto a sheet of paper especially prepared for lithographic use, all of which would tend to soften the finished print. (See Figure 10.)

Although four-color work is probably the most common, a job lithographed in ten or more colors is not rare. In my small collection of domestic and foreign lithographs, some show twenty impressions each printed in a different shade or hue, and all in perfect register. Especially fine are some maps made by the Sveriges Lithografiska Tryckerier of Stockholm.

The very expensive reproductions of famous paintings are usually done in twelve colors and gold. By the way, gold is not printed from gold-colored ink, but actually from a neutral grey ink and, while the ink is still wet, powdered gold (actually a bronze) is dusted on and excess removed.

Dry Lithography

Since the whole process depends on the moistening and inking of the plate, successful efforts have been made to incorporate the water in the greasy ink as an emulsion. This is a form of so-called "dry" lithography.

Ink

The type of lithographic ink used depends on the nature of the paper on which the ink is to be transferred. An ink to be printed on paraffin paper

Courtesy Commercial Engraving Publishing Co.

FIGURE 10.—SCOTT ROTARY OFFSET PRESS SHOWING THE ZINC PRINTING PLATE AND THE RUBBER OFFSET BLANKET

must not "bleed" when the paraffin is hot, while one made for soap wrappers must not be bleached by the alkalinity of the soap. Outdoor posters require ink which is unaffected by sun and rain. Since metal signs and tobacco tins are sometimes printed lithographically, after which the ink is baked on the metal, such ink must be able to withstand this drastic treatment.

The ordinary lithographic ink contains linseed oil, which has the advantage over most other drying oils in that it will spread into the paper or sideways but very little. Some drier is added to permit of drying in a moderate length of time. These driers are usually resinates and acetates of manganese, lead, or cobalt. The coloring agent may be a pigment or lake.

The litho crayon mentioned is made of beeswax, shellac, tallow, turpentine, soap, and lampblack. Tusche is a still softer form of the above, containing more grease, while if diluted to a still greater extent it becomes the transfer ink.

All the various lithographic processes also lend themselves to the production of illustrations, either in mono- or multi-color. There are several continental weekly and monthly periodicals printed lithographically. If the printing plate could be made to withstand a half million impressions, its usefulness along these lines would be greatly increased.

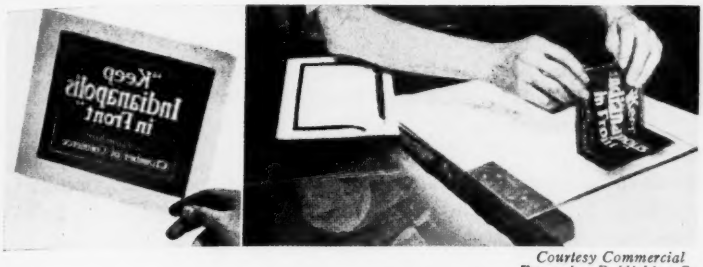
Photogelatin Process (Lichtdruck, Collotype, Heliotype)

As will be noticed later, this process is essentially a planographic one. It is one of the few methods giving almost continuous-tone gradations, simulating a photograph. It does not use a screen although under the hand lens the finished print does show that the printing surface had been broken up into millions of smaller areas. The finished print will be infinitely softer than ordinary relief print and will show even more beautiful effects than a lithograph.

This, another bichromate-gelatin process, depends upon several important facts for its usefulness. The first is that gelatin to which potassium dichromate, $K_2Cr_2O_7$, or ammonium dichromate, $(NH_4)_2Cr_2O_7$, has been added, tans or becomes hardened and insoluble on exposure to light. The second is that the water-absorbing and ink-resisting quality of the exposed gelatin is inversely proportional to the intensity of the light falling in that area. By that I mean that the highly tanned gelatin will take ink and resist water, forming the "solids" while the tones are formed from the more or less water-absorbent and ink-resistant, partially tanned gelatin.

The process is as follows. A ground glass plate, thick and strong enough to be used on a printing press, is first thoroughly cleaned and then coated with an aqueous solution of albumen or dextrin, containing a few drops of sodium silicate. As soon as the first coat is dry, a second coat of the same material is applied. This prepares the plate for the sensitive bichromate-gelatin solution which is flowed on and permitted to dry. The plate is now ready to receive the image.

Previously a continuous-tone negative of the subject, in other words a photographic negative, has been made. If a prism has been used in the making of this negative, the negative can be used unchanged, otherwise the developed silver-gelatin film must be stripped from its glass support and reversed onto another piece of glass. If this were not done, the printed image would be reversed and printed matter, for example, would read from right to left. As in most processes wet plates are generally used. These plates are made by the operator when wanted and are used wet. He generally pours an emulsion of a soluble halide, usually lithium iodide, in



Courtesy Commercial Engraving Publishing Co.

FIGURE 11.—THE NEGATIVE (*Left*) AND STRIPPING AND TURNING IT (*Right*)

collodion, over the cleaned glass plate and allows the ether and alcohol solvents to evaporate. This operation can be carried out in the light. When ready to be used, he immerses the plate, in the dark room, in a silver nitrate bath, forming the light-sensitive silver halide grains over the entire surface of the plate.

These wet plates are primarily used because the developed image can be stripped off the glass, permitting the glass to be used over and over again. It is this economy which compensates for the trouble involved. The common method of stripping the film is to coat the developed-image side with a rubber cement, then, when dry, adding a coat of collodion. When this second coat is dry, the plate is immersed in a dilute acetic acid solution which causes the gelatin film to swell and soften and become readily removable from the glass, with perfect safety. This process is known as "stripping" the negative and is used in practically all processes. (See Figure 11.)

The bichromate gelatin surface of the glass plate, under the reversed negative, is now exposed to light, the time of exposure depending on the type of light and its source, as well as on the density or opacity of the negative. After suitable exposure, the bichromate-gelatin plate is soaked in cold water for several hours, then air dried. The plate is clamped horizontally in a press similar to a lithographic hand press, except for the omission of the dampening roller, and is moistened with an aqueous glycerin solution, which keeps the surface "ever-damp." The plate is then inked with lithographic ink and printed on paper, especially good grades being ledger and bond.

Sometimes the "key" illustration is printed by the photogelatin process and the colors added lithographically. Another procedure is to transfer the inked impression from the glass plate to a litho stone or plate and then print lithographically. And again the colors are sometimes added by hand tinting.

Due to the type of printing surface, the number of good impressions possible from a plate is quite limited. Furthermore the printing surface is not a permanent one and does not permit of long storage. Consequently, reprints of an edition must be made from a new plate.

Additional References

Some valuable and interesting books, besides those already mentioned, which are in practically all public libraries are:

BROWNE, "Practical Textbook of Lithography," The National Lithographer, N. Y. C., **1912.**

BROWNE, "Offset Lithography," The National Lithographer, N. Y. C., **1922.**

RHODES, "The Art of Lithography," Scott, London, **1924.**

CLERC, "Manual of Process Work," Ilford, London, **1924.**

There is located at the University of Cincinnati the Research Division of the Lithographic Technical Foundation. Since its organization in 1925 some very fine work has been done by Prof. Robert Reed and his research staff. It is to them that we are indebted for the illustrations 5, 6, 7, and 9.

New Ether Treatment for Whooping Cough. Results obtained with a new method of administering ether in cases of whooping cough were described by Dr. W. Ambrose McGee of Richmond at the recent meeting of the Southern Medical Association. Ether has an antispasmodic action which physicians are trying to use to lessen the intensity of the paroxysms of whooping cough and also to shorten the duration of the disease.

While some scientists have tried hypodermic injections of the ether into the muscles, Dr. McGee has had considerable success with another method of injection by which the drug is absorbed directly from the intestinal tract. This new method of treatment is not a specific cure, but Dr. McGee found it more effective in relieving the symptoms of the disease than other methods of treatment now commonly used. By rather literally taking the whoop out of whooping cough, the small patient is kept from becoming so exhausted and therefore he can recover from the disease more quickly.

The ether injections gave more consistently satisfactory results than the various whooping cough vaccines, Dr. McGee reported. He also stated that this treatment is more successful the earlier in the disease it is started. For this reason he stressed the importance of early diagnosis of whooping cough and declared that a simple blood test combined with other examinations make it comparatively easy to arrive at the desired early diagnosis.—*Science Service*

Brightness of Light Standard Measured by Scientists. The brightness of the Waidner-Burgess Standard of Light has been measured by scientists at the U. S. Bureau of Standards, members of the National Academy of Sciences were recently told.

This scientific feat was accomplished by devising, for comparative purposes, what is known scientifically as a "black body"—an object which at any given temperature will give out more radiation of every wave-length than any other source at the same temperature. For this purpose a tube of fused thoria was immersed in a bath of purest platinum. The precious metal used had a purity higher than 99.9996 per cent. The platinum was then melted, and the observations were made as it solidified.—*Science Service*

THE PEANUT INDUSTRY. III. PEANUT PRODUCTS*

D. F. J. LYNCH, WASHINGTON, D. C.

Peanut Butter

Types of Peanuts Used.—In any consideration of peanut products the manufacture of peanut butter must have a prominent place. This food-product industry is about twenty-five years old. From 1907–19 the industry had its most rapid growth, increasing five-fold within the twelve years. Since 1919, however, there has been little increase in the consumption of peanut butter. The industry accounts for six to eight million bushels of peanuts annually.[18] The types used by the peanut butter manufacturers are the Virginia, the Spanish, and the Southeastern Runner. The Valencia peanuts make an excellent quality of peanut butter but the cultivation of this variety is hampered because of the tendency its pods have of dropping off the vines in the harvesting. The grade of nuts selected by the manufacturer is, however, more important than the variety. No. 3 peanuts, which consist of broken kernels and small shriveled peas, known as "pegs," should never be used for the preparation of peanut butter.

A few factories do however use No. 3 peanuts in making butter, sometimes called "confectioners' peanut butter." When received from the cleaners the No. 3 goods are dumped into tubs of water; the sticks and trash are scooped off the top; dirt and stones sink quickly to the bottom; and the peanuts in between are removed and then slightly picked over before being ground into butter.[19]

Method of Manufacture.—Peanut butter is generally prepared by grinding well-roasted and carefully blanched peanuts, and, as a rule, contains no other ingredient, except salt. The quality depends, to a great extent, upon the grade of nuts selected, but to a degree upon the variety of nuts chosen, or more often upon the proportion of the different varieties blended in its preparation, and also upon the care exercised in the following operations. Many manufacturers use a mixture of Virginia and Spanish nuts in the preparation of their product, explaining that the Virginias absorb the excess oil of the Spanish nuts and give a beautifully smooth and fine-flavored butter.

Roasting.—The actual production of peanut butter consists, usually, of six steps which are grouped into four operations.[20] The first step in the process is the roasting. By far the majority of the manufacturers buy shelled goods for roasting, although there are some who roast un-

* Part I of this series of articles appeared in THIS JOURNAL, **7**, 794–811 (Apr., 1930); Part II, **7**, 1037–50 (May, 1930).

[18] *Am. Food J.*, **22**, 134 (Apr., 1927).

[19] *Bur. Plant Industry Circular* **98** (1912), U. S. Dept. of Agriculture.

[20] *The Spice Mill*, **44**, 1850 (1920).

shelled nuts. In such a plant the shelling of the nuts should be carried out in another building, because the dust of a shelling plant is sure to contaminate the butter if both processes are carried on in the same building. The roasting of shelled goods demands considerable care as upon this step depends the flavor and color of the final product.

The source of heat for roasting varies from natural gas to a coke fire. The operation is carred on at about 320°F. and the time required varies from 20 to 60 minutes. The goal aimed at, in the roasting, is perfect uniformity in the product. This uniformity is attained by slowly rotating the roasting cylinder and accurately regulating the heat. The interior of the roasting cylinder should be smooth and the movement slow, otherwise the red skin loosened by the heat will be rubbed off and the kernel burnt and discolored. The accurate control of a draft of air through the roasting batch and out of the cylinder aids the operator in obtaining uniformly roasted nuts. The shelled nuts are fed into the roasting cylinder through a large hopper at the top. This hopper is of sufficient size to hold a full charge of nuts for the roaster and, therefore, little time is lost after the unloading of one batch before the roaster is turning again with its next charge.

Cooling.—The step following the roasting is known as cooling. When the batch has reached the desired color it is discharged from the roasting cylinder into the cooling box. Batches are usually described by the operators as a "high-roast" or a "mild-roast." Some markets prefer the "higher-roasted" nuts. The "mild-roast" is considered, by the majority of the people, however, as more palatable and wholesome. Too light roasting, on the other hand, produces a peanut butter lacking in flavor, color, and good keeping qualities.

To obtain perfect uniformity and prevent some of the kernels from becoming too brown, artificial cooling is necessary. This is accomplished in the cooling box which is equipped with a false bottom and a connection with a suction line. Air is drawn down through the hot batch at such a rate as to effect a reasonable rapid cooling of the nuts. After cooling, the connection with the suction line is broken and the cooling box, which is on wheel, is rolled to a bucket elevator or floor hopper and there unloaded. The elevator or floor hopper controls the flow of goods for the effective operation of the blanching machine.

Blanching.—In the next operation—blanching—the red skin and the 'heart" of the kernel are removed. Both detrimentally affect the palatability of the butter and the skins also affect the appearance. The presence of any considerable quantity of hearts in the peanut butter is also believed to promote premature rancidity. A specky appearance results if the skins are ground with the meats, and they give a slightly bitter taste to the butter.[21] The blancher is constructed of corrugated plates

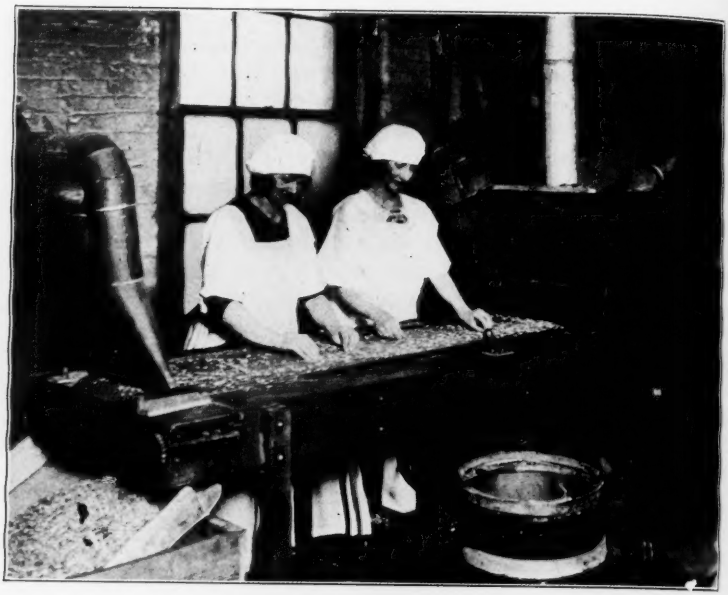
[21] *U. S. Dept. Agr. Bull.* No. **1401.**

which hold the nuts momentarily while the revolving brushes remove the skins. A suction or blast line removes the skins to a collecting chamber. These red skins can be sold to the oil pressers as the oil content is high enough to make the commercial extraction of the oil profitable. The operation of blanching is very important and much care is demanded in the design of the blancher to attain the desired well-blanched kernels with the smallest amount of "meal." The machine should be constructed so as to allow adjustment of the brushes while running, and allowance should also be made for easy access to the interior of the machine for complete inspection and keeping clean all parts of the machinery which come in contact with this food product.

This operation should be called split-nut blanching to distinguish it from the blanching as carried on by the Virginia salted peanut producer, where the desired product is the whole kernel. In this blancher the kernels are split by the plates and then thrown on a screen which sifts out the "hearts" and broken kernels known as "meal" and carries the half kernels on to the next process. The hearts, the other by-product of blanching, can also be sold as they have gained some popularity as a pigeon and poultry feed.

Cleaning and Picking.—The blanched split kernels are then subjected to cleaning and hand picking. Even the best commercial grade of nuts contain some shriveled or unsound kernels. The extent to which the cleaning must be carried at this point depends on the grade of stock purchased and the quality of the peanut butter desired. High-quality peanut butter can be prepared from a lower grade of stock if the cleaning and hand picking is such that all the imperfect nuts are removed. No. 2 nuts differ from No. 1 nuts in the size of all the nuts in that class and the number or percentage of shriveled kernels allowed in that grade. Sound No. 2 nuts are just as sound as sound No. 1 nuts, differing only in size. It is, therefore, for the individual manufacturer to decide whether he will buy No. 2 nuts at a lower price and spend more money on his cleaning and hand-picking operation.

The material to be removed from the sound half-kernels is either sufficiently heavier or lighter than the kernels to effect a good air separation. The goods pass through a carefully regulated upward blast of air which lifts the kernels and the lighter material, allowing the undesirable heavier material to fall out into a receptacle below. The efficiency of this separation is affected by the fact that the kernels are made lighter by roasting and the splitting has given more surface to the lifting air blast. The kernels with the lighter material are then deposited on a moving belt which, in carrying the kernels to the picking tables, bring them under the "chaffer." The "chaffer," by means of a carefully regulated suction, picks out and carries away the loose, light, foreign material.



PICKING TABLE IN A PEANUT-BUTTER PLANT
Burnt peanuts and foreign matter are removed by hand and light material by suction before the peanuts pass to the peanut-butter mill.

Hand picking of the nuts is needed if only to act as an inspection of the goods and as a check on the efficient operation of the plant. After passing under the "chaffer" the moving belt carries the goods smoothly and at a slow speed over the picking table. The hand pickers sit on both sides of the table and inspect the flow of kernels as they pass, removing the imperfect nuts. The work here increases with a drop in quality of the raw stock purchased and without any drop in efficiency of the preceding operations. In the operations referred to, the manufacturers will lose 5 pounds in 100 pounds of average No. 1 shelled nuts in the roasting, an additional 9 pounds in blanching and 1–1½ pounds in the hand-picking operation.[22]

Mixing.—If the producer desires a peanut butter made from more than one variety he usually mixes the nuts at this point, just before grinding. As mentioned above the nuts can be mixed in the roasting cylinder but this method makes the blanching and cleaning more difficult and less efficient. Today most plants use special mixers of which the "two-conveyor mixer" is an example. Two short screw conveyors, mounted side by side and connected by spur gears, carry the nuts to the grinder.

[22] *Plant Industry Circular* **98** (1912).

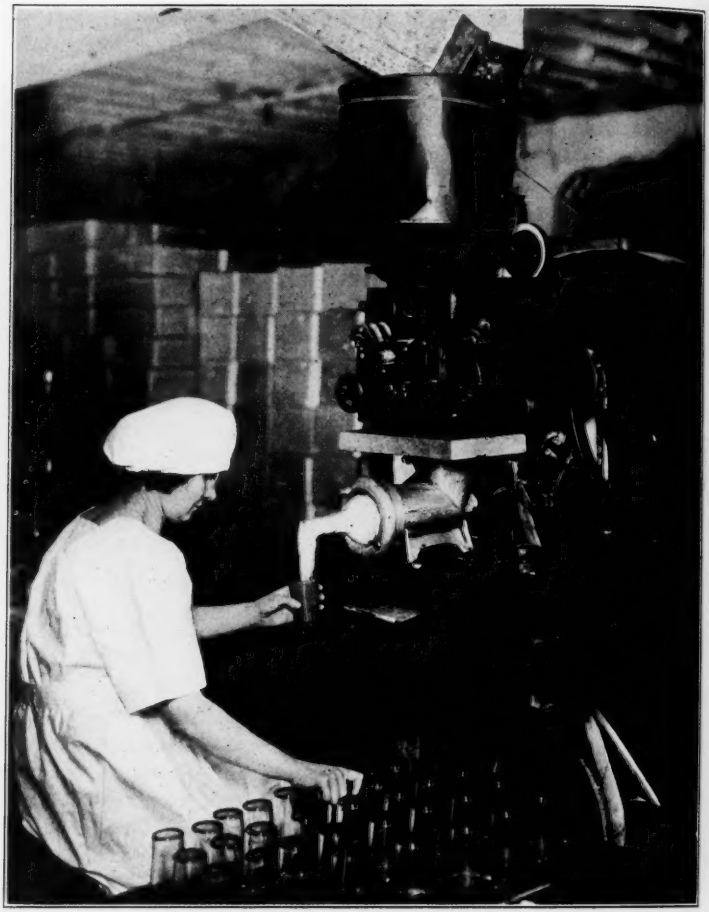
The tooth ratio of these gears determine the relative speed and therefore the relative amounts of the two varieties of nuts delivered to the mill. Sets of gears are purchased with these mixers which will vary the proportions of the nuts delivered to the mill as desired.

Grinding.—The actual grinding of the kernels is not difficult. The grinding mill desirable in a peanut-butter plant should be variable at will, for producing a product which may vary from a distinctly grainy consistency to a "dead smooth" paste. It should be so constructed that the grinding parts can be easily removed for the replacement of new disks as well as afford convenient access to the interior of the mill for cleaning.

It has been learned by experience that the most important requirement in the grinding operation, for the delivery of a uniform butter, is to keep the mass under a constant pressure throughout the mill. The popular mill, today, is built to meet this need. In the center of the mill is a heavy revolving screw which forces along the crushed mass at a constant pressure through a pair of adjustable grinding disks, into the discharged spout, for delivery in a continuous stream to the peanut-butter containers. It is upon this constant pressure that the desired uniform consistency of peanut butter depends. There is, of course, attached to the mill an automatic salt feeder. The amount of salt added varies with the manufacturer and the market which he is supplying at the time, but usually amounts to 1 to 4% of the weight of the butter. The best grade of dairy salt is used and it must be uniformly distributed throughout the product.

The operator of the grinding mill desires to break apart the minute oil cells but does not wish to injure the cell and liberate the oil. If he succeeds the butter is finely granular. A too coarse grind produces a butter that has an objectionable gritty feel. A smooth pasty consistency, on the other hand, would indicate a liberation of the oil with attending injury to the oil cell. When consumed this "dead smooth" butter has the disagreeable tendency of sticking to the roof of the mouth. Grinding plates which have been worn smooth tend to rub and injure the cell, so as to liberate the oil, giving a paste which lacks the proper consistency and does not hold up well. A similar inferior butter is also caused by the overheating of the crushed nuts in the grinding mill.

Packing.—Although it is the usual custom to fill the peanut-butter containers at the grinding mill, a few plants are equipped with separate filling machines. When the jars are full they are capped with covers under a high vacuum. There is only one added precaution which the peanut butter manufacturer must observe above those precautions generally necessary in packing any good product. Rubber must not be used in the rings which are customarily put under the cap to effect an air-tight seal. Rubber is somewhat soluble in peanut oil. There is a large amount of peanut butter sold "in bulk," which means in large pails which are not sealed air-

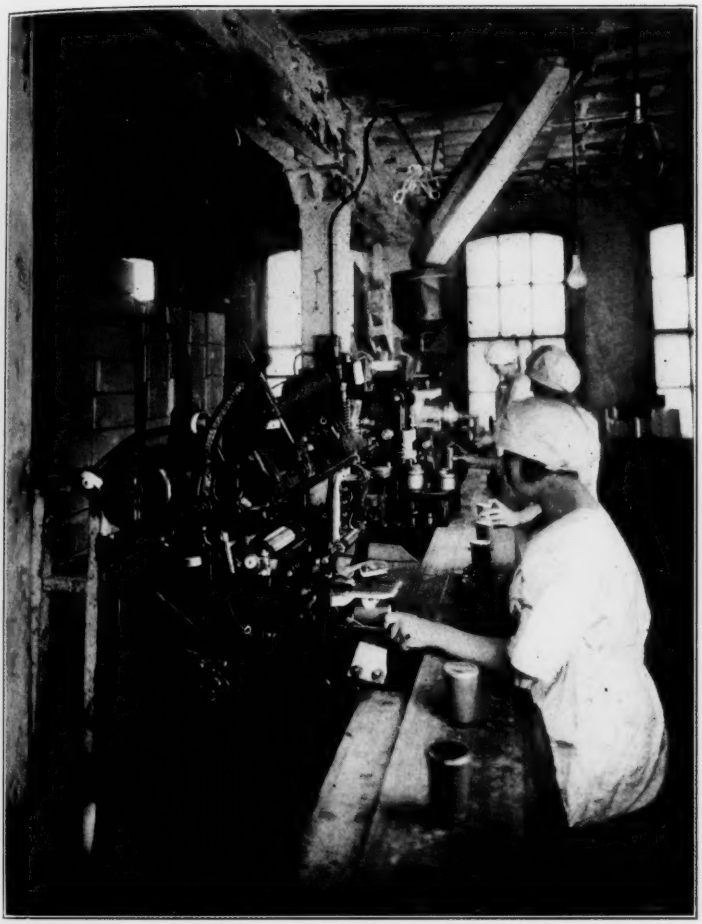


FILLING GLASS JARS WITH PEANUT BUTTER

The peanuts drop into the hopper at the top of the mill, are ground up, nothing but salt is added, and the completed product, peanut butter, comes out the spout.

tight. Exposed to air the butter will not keep as long and soon becomes rancid.

Very often proper care is not exercised in the retailing of peanut butter in bulk. The product is allowed to stand uncovered and exposed to dust. No attempt seems to be made to make its appearance inviting and in general there exists much to be desired in the present method of selling this grade of peanut butter.



FILLING, CAPPING, AND LABELING GLASS JARS OF PEANUT BUTTER
An endless belt carries the jars from one machine to another.

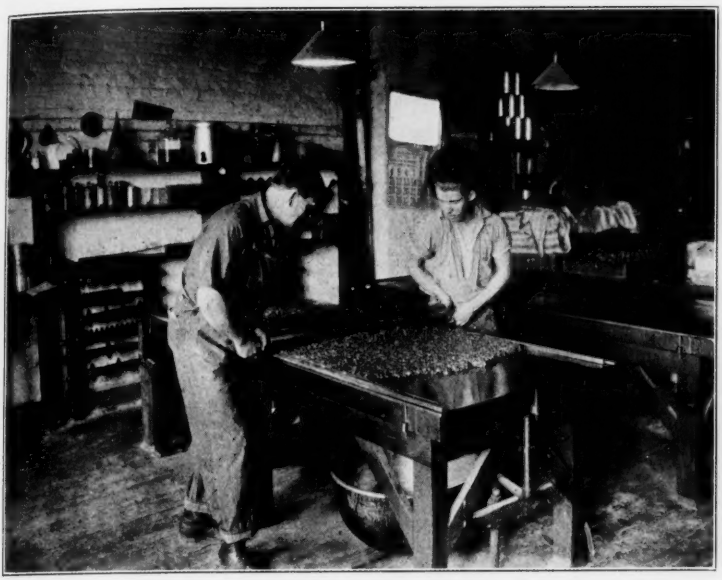
Keeping Quality.—The distributors and consumers of peanut butter encounter only two difficulties. The first one is the separation of the oil on the top of the butter. The directions to stir up the butter and oil are all right but all prefer a product that does not have to be stirred up. F. W. Stockton[23] advocates the addition of hydrogenated peanut oil or other solid fat and grinding the mixture into a homogeneous mass and

[23] U. S. Pat. 1,395,934.

claims that the separation of the oil on the top of the butter is thus prevented. W. W. Willison[24] claims to accomplish the same result by incorporating 10 per cent of water in the butter which he claims serves to expand the starch cells so that segregation of the oil is prevented. J. L. Rosenfield suggests that we prepare a product with the desired properties by removing a major portion of the oil in peanut butter and mix with the residue, while hot, some hydrogenated edible oil[25] and he considers the replacing of a portion of peanut oil with cocoanut oil will impart to the product the desired characteristic. J. H. Beattie and A. M. Jackson[26] claim to have solved this difficulty for the peanut butter manufacturers by subjecting the peanut butter in air-tight containers to steam pressure at 250 degrees Fahrenheit for fifteen minutes. It is claimed that this patented treatment prevents the subsequent separation of the oil from the solid material in the peanut butter and also improves the keeping quality of this food product. Samples subjected to this treatment are reported to have been kept in ordinary storage for periods of two years or more without the development of rancidity or the separation of the oil from the solid matter. The other undesirable characteristic of peanut butter is the tendency it has of clinging to the roof of the mouth. Many manufacturers claim that this can be avoided by a change in the mill to produce a coarser product. D. W. Howe claims that this tendency can be prevented in any peanut butter by the uniform distribution throughout the product of about 5 per cent of dextrose.[27]

Analyses.—R. O. Baird of North Dakota[28] has made a large number of analyses of the various brands of peanut butter. He reports as minimum and maximum results that the moisture content varied from 1.21–2.54 per cent and the ash amounted to 2.09–3.4 per cent. He found 1.54–2.31 per cent crude fiber in the butter. The main components—crude fat, protein, and nitrogen-free extract—varied 43.88–55.30 per cent, 29.93–34.05 per cent and 7.22–17.82 per cent, respectively. It can be safely assumed that the fat content in peanut butter will be about 45 per cent, the protein content nearly 30 per cent and the carbohydrate content nearly 17 per cent. Jaffa[29] gives 2825 calories per pound as the fuel value of this food. The people of this country spend something over $10,000,000 a year on peanut butter, consuming about two-thirds of a pound per capita.[30]

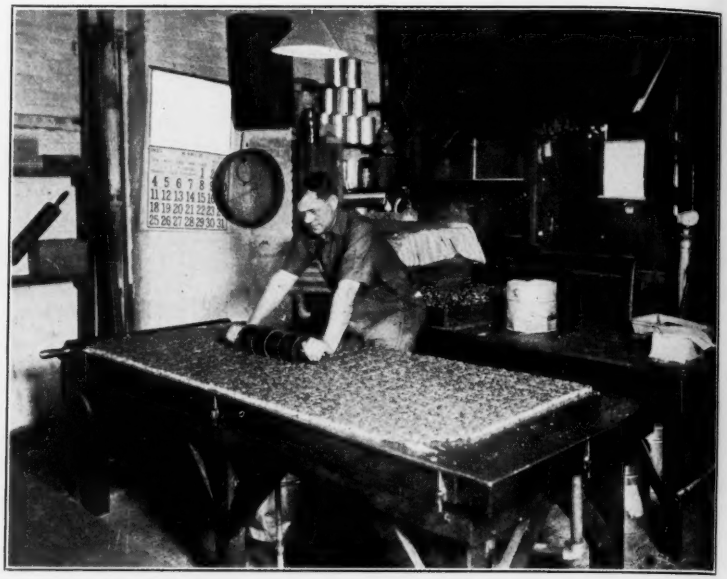
[24] U. S. Pat. 1,398,352.
[25] U. S. Pat. Reissue 15,918.
[26] U. S. Pat. No. 1,731,647, Oct. 15, 1929.
[27] U. S. Pat. 1,696,766, Dec. 25, 1928.
[28] *N. D. State Food Comm. & Chem. Bull.*, **3**, 1–3 (1923).
[29] *Farmers Bulletin* **332**, U. S. Dept. of Agriculture.
[30] F. E. Craxton, *Am. Food J.*, **22**, 134 (April, 1927).



ROLLING OUT PEANUT CANDY, PREPARATORY TO CUTTING IT UP INTO 5-CENT BARS
The iron "rails" at the sides of the table keep the candy to a uniform thickness.

Peanut Candy

As users of shelled peanuts the candy makers are nearly as important as the salters and peanut-butter manufacturers. Although shelled Runners are sometimes substituted for Virginias in the cheaper grades of candy, this demand is supplied chiefly with No. 1 Spanish and Virginia nuts. Extra large grade Virginia nuts are sometimes substituted for almonds in chocolate bars. The peanuts usually reach the consumer of peanut candy in the form of peanut brittle or peanut bars. Peanut brittle is the older form of peanut candy and is still in demand by the public. It is composed of peanuts and sirup made from cane sugar and glucose. Of recent years, until the present dieting fad became so popular with the consuming public, each week saw a material increase in the demand for the 5-cent candy bar. Large amounts of peanuts are used by the manufacturers of this type of candy. The peanut bar is also composed of peanuts and a sirup of glucose and cane sugar, which is often coated with chocolate. A newer type of peanut confectionery is sugar-coated peanuts which are known to the trade as "burnt peanuts." These are prepared by thinly coating the nuts while warm with a sirup. During the operation the kernels are tumbled in a pan and by rubbing against each other



CUTTING PEANUT CANDY INTO 5-CENT BARS

As the candy hardens quickly, the cutting must immediately follow the rolling to a uniform thickness.

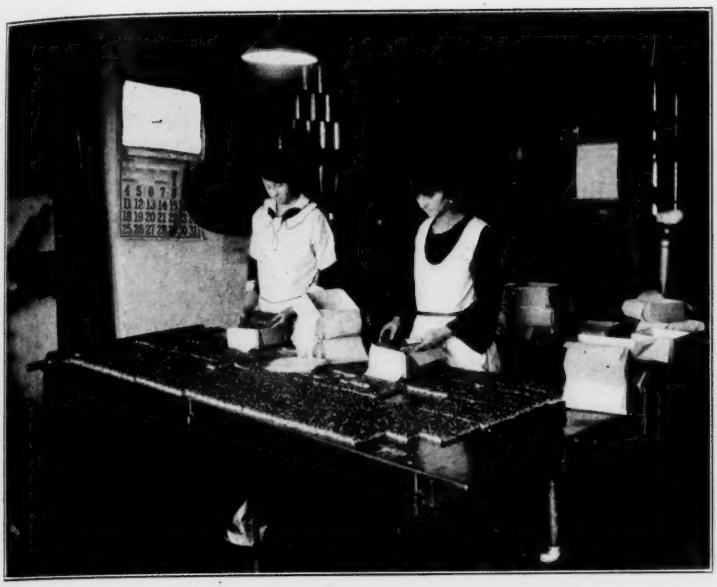
the kernels acquire the desired roughened appearance.[31] Of late some of the peanut crop has been absorbed by the bakeries in the production of peanut cookies, peanut jumbles, and, upon grinding, for sprinkling on the top of bakery products.

Peanut Flour

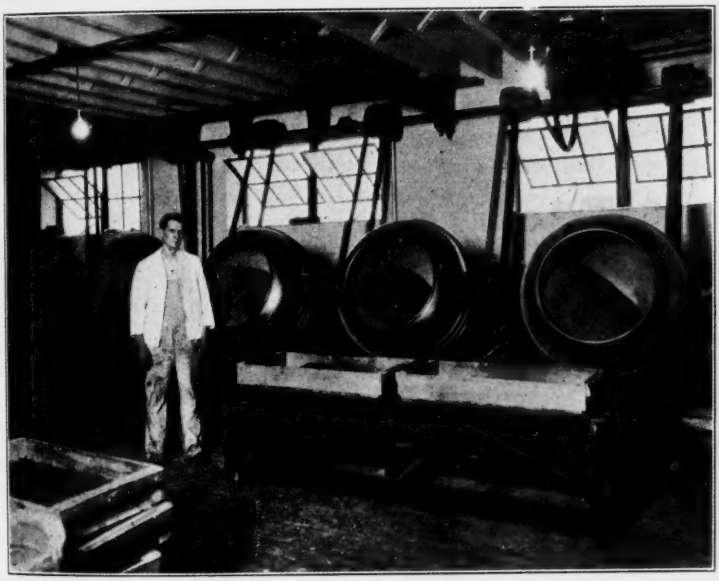
Another form in which peanuts may reach the consuming public is known as peanut flour. Peanut flour can be obtained directly from raw or roasted peanuts or from peanut cake. Peanut cake is the residue left in the oil press after pressing out the peanut oil. Only that peanut cake made from pressing the best grade of shelled nuts is available for peanut flour. If made by grinding up the whole kernel the flour has, of course, the same composition as the peanut. When made, as usual, from peanut cake the flour is a very high protein foodstuff. Peanut flour is wholesome, palatable, and nutritious, containing four times as much protein, eight times as much fat, and nine times as much mineral ingredients as white wheat flour.[32] For bread-making the addition of

[31] *U. S. Dept. Bull.* **1401.**

[32] U. S. Dept. of Agriculture Yearbook, **1917,** pp. 295–6.



PACKING PEANUT CANDY IN CARDBOARD BOXES LINED WITH PARAFFINED PAPER



MAKING "SUGAR-COATED PEANUTS," KNOWN AS "BURNT PEANUTS" BY THE TRADE
Note the steam coils around the outside of the revolving pans.

about two or three parts of peanut flour to ten of white flour is advised by the experts in home economics. Although a considerable amount of peanut flour was used during the war as a wheat substitute, the demand dropped after the war.

Nutrition Value of Peanuts and Peanut Products

Palatability is the governing factor in the introduction of a new food product, but its sustained consumption over a period of years must depend on its wholesome and nutritious qualities. The digestibility of peanuts has been studied by A. D. Holmes. Mr. Holmes fed steam-cooked soy bean and peanuts and the soy-bean flour and peanut flour in comparative experiments to young men engaged in moderately active pursuits.[33] Peanuts or soy beans or their respective flours were the source of protein in a 3100–3240 calorie diet. No digestive or other physiological disturbances were noted. Eighty-six per cent of the peanut flour was digested, which compares favorably with other cereal proteins and is higher than other legume proteins. Since fat-soluble vitamin A and water-soluble vitamin B are present in peanut flour, it seemed to this investigator that peanut flour was especially valuable as a food for men.

During the digestion proteins are broken down into about sixteen amino acids which in the body are formed into new proteins. The value of a protein depends on the relative quantities of the various amino acids it gives on digestion. Some proteins lack entirely those amino acids necessary for growth and will not therefore support life. Peanut protein contains all the amino acids necessary for growth.[34] This fact was experimentally demonstrated with white rats. Peanuts are therefore very valuable in supplementing cereals which are deficient in certain of these essential substances. It is not difficult to digest the peanut either in form of peanut flour or peanut butter, but these are concentrated foods, supplying about 2500 calories to the pound, which is sufficient energy for twenty-four hours for the normal person.

Lichnikov in his search for the amino acids which make up peanut protein successively extracted the protein with water, 70 per cent alcohol, 10 per cent solution of sodium chloride, and a 0.25 per cent solution of KOH. Upon the hydrolysis of globulin the amino acids histidine, arginine, and lysine were separated.[35] It is to C. O. Johns and his co-workers that we are indebted for most of our knowledge of the proteins in peanuts. In 1916 these chemists isolated from the peanut the two globulins, arachin and conarachin.[36] Upon analysis of these two proteins arachin yielded 0.4 per

[33] *U. S. Dept. of Agriculture Bull.* **717**; see also *J. Am. Med. Assoc.*, **74**, 798 (1920).
[34] C. O. Johns, *Cotton Oil Press*, **2**, No. 12, 41–2.
[35] *Rec. Trav. Lab. Agron.*, **9**, 378–85 (1913).
[36] *J. Biol. Chem.*, **28**, 77–87 (1916).

cent sulfur and 4.96 per cent basic nitrogen, while conarachin gave 1.09 per cent sulfur and 6.55 per cent basic nitrogen. In the case of conarachin this is the highest recorded basic nitrogen in any seed protein, and this discovery led these men to suggest peanut flour as a food to supplement cereals and other seeds whose proteins are deficient. In 1917 the same investigators hydrolyzed both of these proteins into their amino acids and made the following report:[37]

TABLE I

	Arachin	*Conarachin*
Arginine	13.51%	14.60%
Histidine	1.88	1.83
Lysine	4.98	6.04
Crystine	0.85	1.07

They were also able to obtain a qualitative test for tryptophan. The above content of lysine is high, approaching the lysine content of muscle. It may be remarked here that wheat and corn are deficient in lysine. In 1918 these same chemists isolated from arachin other rare amino acids in the following amounts: alanine, 4.11 per cent; valine, 1.13 per cent; leucine, 3.88 per cent; proline, 1.31 per cent; phenylalanine, 2.61 per cent; aspartic acid, 5.25 per cent; glutarnic acid, 16.69 per cent; and tyrosine, 5.5 per cent.[38]

With a food product as important to mankind as the peanut there would be naturally a large amount of nutrition research. Johns and Finks demonstrated that with peanut flour as the only source of protein in an otherwise adequate diet the coefficients of digestibility for peanut protein, fat, and carbohydrate, are respectively, 89 per cent, 96 per cent, and 97 per cent. Upon this diet young rats showed normal growth.[39] Feeding experiments with rats using peanuts as the source of protein by A. L. Daniels and R. Poughlin show that this protein, which contains considerable amounts of water-soluble vitamin B, is adequate for normal growth, maintenance, and reproduction.[40] In 1928 W. H. Eddy and R. S. Eckman carried out comparative experiments with rats to determine the relative values of meat and peanut proteins. The diets were so planned that with the exception of the protein they were otherwise equal. In these experiments peanut flour proved slightly superior to meat in producing growth and markedly superior in the promotion of reproduction.[41]

As might be expected marked interest in the nutritive value of peanuts has been manifested in the Orient. T. Shiba and M. Kayama report that

[37] *J. Biol. Chem.*, **30**, 33–8 (1917).
[38] *Ibid.*, **36**, 491–500 (1918).
[39] *Am. Food J.*, **14**, No. 4, 2 (1919); see also *J. Biol. Chem.*, **42**, 569–79 (1920).
[40] *J. Biol. Chem.*, **33**, 295–301 (1918).
[41] *Ibid.*, **55**, 119–29 (1923).

peanut protein is superior to that of the soy bean in producing growth,[42] while N. Suzuki and his co-workers find that peanuts are to be preferred to rice as a source of protein.[43] K. L. Mackenzie-Wallis[44] finds that quite apart from the oil the nutritive value of peanut flour is high. Not only is the flour an efficient source of protein, but it is rich in amino acids which make it anti-scorbutic and therefore excellent for supplementing the rich carbohydrate diet of the natives of India. The work of E. D. W. Grieg demonstrated that biscuits made from peanuts were equal in anti-scorbutic potency to the best brand of atta biscuits previously examined, and therefore this investigator recommends peanut biscuits as emergency rations for troops in India.[45] Other experimental work has indicated other possible special food uses for peanut flour. M. B. Church, through her fermentation work with molds from the *Aspergillus flavus-oryzae* group for the preparation of soy bean sauce, suggests the utilization of peanut cake as suitable for the production of similar sauces.[46] Due to the small quantity of utilizable carbohydrate in peanut flour as compared with wheat flour and soy bean flour (which is the common diabetic food), M. K. M. Neale on the other hand suggests a new use for peanut flour in his recommendation that it be substituted for soy-bean flour in diabetic foods.[47]

From the foregoing scientific work it can readily be seen that peanut products are wholesome and nutritious. They far surpass in these respects many food articles which are consumed in larger quantities by our people. As an economic source of protein, peanut products compare favorably with any we have. The protein found in peanuts have been proved to be rich in the rare but important amino acids. All of us can testify to the palatableness of first-grade peanut foodstuffs. So there exists multiple evidence for the continued increasing use of peanut products in our nation's diet.

[42] *J. Chem. Soc. Japan*, **44**, 58–68 (1923).
[43] *Sci. Papers Inst. Phys. Chem. Research*, **4**, 1–47.
[44] *Indian J. Med. Res.* **6**, 45–55 (1918).
[45] *Ibid.*, **6**, 143–6 (1918).
[46] *Spice Mill*, **47**, 168 (1924).
[47] *J. Am. Dietet. Assoc.*, **2**, 73–85 (1926).

Chemical Centenaries in 1930. Among anniversaries which occur in 1930 are a number of chemical interest. Three hundred years ago was born Kunckel (1630–1703), a German chemist. The year 1830 was a "vintage year," for in it were born the Frenchman Raoult (1830–1901) whose work helped to lay the foundations of physical chemistry, and who received the Davy Medal of the Royal Society in 1892; the Dutchman van Bemmelen (1830–1911), also a physical chemist; and the German Lothar Meyer who made contributions to our knowledge of the periodic classification of the elements, especially by his famous curve of the atomic volumes.—*Chem. Age*

LIQUID AMMONIA AS A SOLVENT AND THE AMMONIA SYSTEM OF COMPOUNDS. VI. ORGANIC AMMONIA COMPOUNDS. PART I. INTRODUCTION. THE AMMONO ALCOHOLS[1]

W. Conard Fernelius, The Ohio State University, Columbus, Ohio, and Warren C. Johnson, University of Chicago, Chicago, Illinois

In an earlier article of this series[2] there was developed an *ammonia system of compounds*. Further, the application of such a concept to the field of inorganic chemistry was discussed at some length. Recently under the leadership of Professor Edward C. Franklin,[3] these same ideas have been applied to the organic side of chemistry with very promising results. Although the study of organic ammonia compounds is only in its infancy, nevertheless one is justified in predicting at this early hour that ammonia chemistry will shortly find here a great application in the study of organic compounds and that research in this field will be very fruitful. Perhaps one reason why the study of the nitrogen compounds of carbon is so productive is due to the greater resistance of these compounds toward hydrolysis as compared to the inorganic ammonia acids, bases, and salts.

Organic Compounds Related to Water

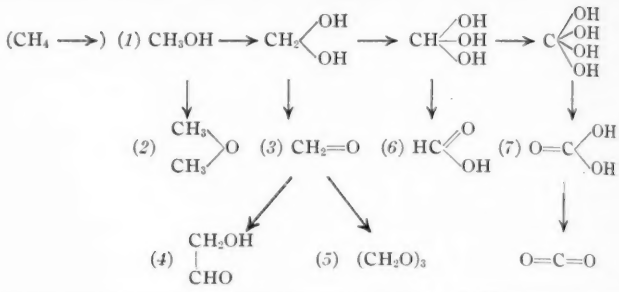
Before discussing the nitrogen analogs of the familiar oxygen compounds of carbon, it might be well to review briefly the more simple types of the latter class of substances. If we write a scheme such as the one below to represent the successive oxidation products of methyl alcohol, a substituted water, the formal interrelationships of a large number of simple organic compounds becomes evident at once. By successive oxidations followed by dehydrations,[4] one can represent in such a scheme (1) the alcohols, (2) ethers, (3) aldehydes, (4) aldol condensation and (5) polymerization products of the aldehydes, (6) carboxylic acids, and (7) carbonic acid. The compounds below the dotted line may be regarded as derived from those above by the replacement of hydrogen by a hydrocarbon radical or by the loss of water between the hydroxyl group of the compounds above the line and alcohols; *i. e.*, $H_2C(OH)_2 + 2HOR \longrightarrow H_2C(OR)_2 + 2H_2O$. Thus, there are (8) ethers (mixed ethers if R is anything other than methyl), (9) acetals and esters of (10) orthoformic, (11) formic, (12) orthocarbonic, and (13) carbonic acids.

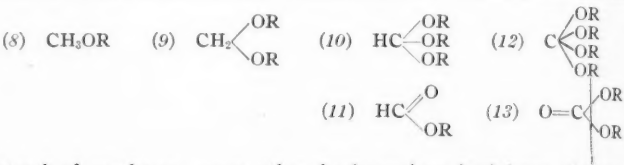
[1] Previous articles in this series have appeared as follows: I, This Journal, **5**, 664 (June, 1928); II, *Ibid.*, 828 (July, 1928); III, *Ibid.*, **6**, 20 (Jan., 1929); IV, *Ibid.*, 441 (Mar., 1929); V, *Ibid.*, **7**, 981–99 (May, 1930).

[2] *Ibid.*, **5**, 828 (July, 1928).

[3] *Ibid.*, **5**, 1208–10 (Oct., 1928).

[4] Bone's "hydroxylation theory" of oxidation [see Bone and Drugman, *J. Chem. Soc.*, **89**, 660 (1906) and earlier papers] is used here to show the formal relationships between the various simple oxygen compounds rather than to postulate a mechanism of oxidation.





If, instead of methane, some other hydrocarbon had been chosen to represent the oxidation scheme the result would have been much the same except that it would have lacked the final oxidation step to carbonic acid,

$$(RCH_3 \longrightarrow)\ RCH_2OH \longrightarrow RCHO \longrightarrow RCOOH.$$

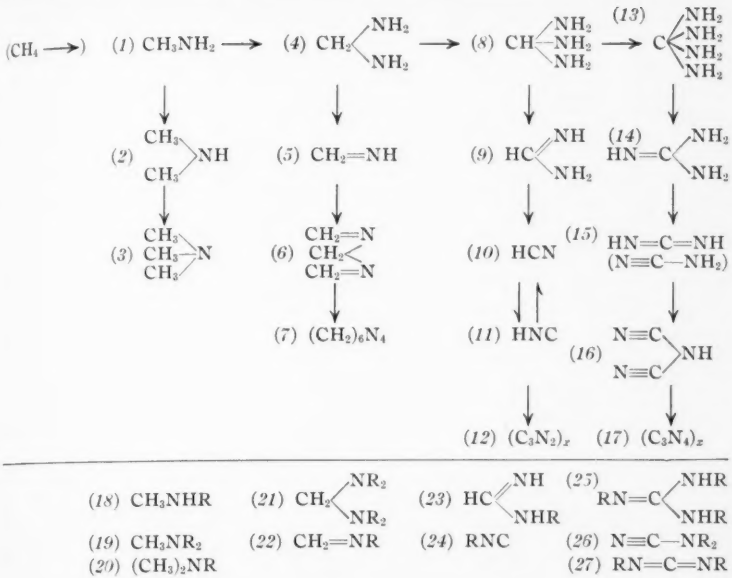
The derivatives of these compounds would be much the same as those of the methyl alcohol group with the addition that the carboxylic acids of more than one carbon atom may lose a molecule of water between two molecules of the acid to form a molecule of an anhydride,

$$\begin{matrix} RCOOH \\ RCOOH \end{matrix} \longrightarrow \begin{matrix} RC{=}O \\ \quad\ O \\ RC{=}O \end{matrix}$$

Organic Compounds Related to Ammonia

With the scheme above for the oxygen compounds in mind, let us write a similar scheme for the nitrogen analogs of these oxygen compounds. In the present case, however, instead of replacing hydrogen atoms successively by hydroxyl groups (—OH) (oxidation), we shall replace hydrogen atoms by amide groups ($—NH_2$) (nitridation).

At times a strict parallelism between the nitrogen and oxygen compounds is a bit complicated because of the trivalence of the nitrogen as compared to the divalence of the oxygen. Also because of this difference in valence certain derivatives of ammonia have no analogs in the water system, but of the several compounds above numerous similarities are seen at a glance. Thus (*1*) and (*2*) are ammono methyl alcohols, (*3*) an ammono methyl ether, (*4*) the ammonia analog of methylene glycol, (*5*)



an aldehyde-alcohol, (*6*) in so far as the two $CH_2{=}N{-}$ groups are concerned, a formaldehyde, (*7*) hexamethylene tetramine, a dimer of ammono formaldehyde, (*8*) ortho ammono formic acid, (*9*) the ammonia analog of formic acid, formamidine, (*10*) formic anammonide,[5] (*11*) ammono carbonous acid, (*12*) carbonous anammonide, (*13*) ortho ammono carbonic acid, (*14, 15, 16*) ammono carbonic acids and (*17*) carbonic anammonide. Of those compounds formed by the replacement of a hydrogen atom by a hydrocarbon radical (or by the loss of ammonia between any of these substances and an ammono alcohol), an amine, *i. e.*, $HC(NH)NH_2 + H_2NR \longrightarrow HC(NH)NHR + NH_3$, the following are clearly what their names indicate: (*19, 20*) ammono ethers (mixed ethers), (*21*) ammono acetals, (*22*) aldehyde-acetals and esters of (*23*) ammono formic, (*24*) ammono carbonous and (*25, 26, 27*) ammono carbonic acids.

Since only a limited discussion of these various nitrogen compounds is possible, we may first say that observations in wide variety are on record in the chemical literature giving convincing support to the general statement that the formal relations involved in the above table are real, and then proceed to the consideration of a limited number of significant reactions, most of which have been accomplished in the laboratories of Stanford University under the able direction of Professor Edward C. Franklin.

[5] For the use of the term "anammonide" see ref. 2, p. 830.

The Ammono Alcohols

The essential characteristic of an alcohol is the possession of an hydroxide group attached to a carbon atom which is in turn linked only to hydrocarbon radicals or to hydrogen. One might say that when an organic compound contains a carbon atom attached to oxygen by a single valence bond the compound is an alcohol (or the ether, aldol, ester, etc., of an alcohol) as far as that carbon atom is concerned. Similarly, an ammono alcohol is a compound containing a carbon atom attached to nitrogen by a single valence bond. Three kinds of oxygen alcohols are recognized, primary, secondary, and tertiary, depending upon the number of carbon atoms attached to that carbon atom which is linked to the hydroxyl group, thus,

CH_3OH	$(CH_3)_2CHOH$	$(CH_3)_2COH$
PRIMARY	SECONDARY	TERTIARY

Similarly, methyl amine, isopropyl amine, and tertiary butyl amine are examples of a primary ammono alcohol, a secondary ammono alcohol and a tertiary ammono alcohol, respectively,

$$CH_3NH_2 \qquad (CH_3)_2CHNH_2 \qquad (CH_3)_3CNH_2$$

It will be noticed that this scheme of classification takes no account of the familiar classifications of amines into primary, secondary, and tertiary, depending upon the number of hydrogen atoms in the ammonia molecule that have been substituted by hydrocarbon radicals. Indeed, if we consider ethyl amine, diethyl amine, and triethyl amine,

$$CH_3CH_2NH_2 \qquad (CH_3CH_2)_2NH \qquad (CH_3CH_2)_3N,$$

we find that, whereas they are a primary, secondary, and tertiary amine, respectively, the first two are primary ammono alcohols and the third is an ether derived from a primary ammono alcohol. Obviously these two primary-secondary-tertiary groupings are in no way related. It is apparent, too, that we shall encounter, in the ammonia system, mixed alcohols, *e. g.*:

CH_3 $(CH_3)_2CH$ >NH	CH_3CH_2 $(CH_3)_3C$ >NH	$(CH_3)_2CH$ $(CH_3)_3C$ >NH
PRIMARY-SECONDARY AMMONO ALCOHOL	PRIMARY-TERTIARY AMMONO ALCOHOL	SECONDARY-TERTIARY AMMONO ALCOHOL

In the water system mixed alcohols cannot occur because the oxygen atom possesses only two replaceable hydrogen atoms. All the tertiary amines are ammono ethers. Just as the aquo ethers have no hydrogen attached to oxygen so the ammono ethers have no hydrogen attached to nitrogen.[6]

[6] For a discussion of the classification of ammono alcohols, see Strain, *J. Am. Chem. Soc.*, **49**, 1558 (1927).

Physical Properties of the Ammono Alcohols.—In physical properties the amines are similar to the alcohols. Consider the solubilities of the two classes of substances in liquid ammonia and in water, respectively. Ethyl alcohol, C_2H_5OH, is soluble in water in all proportions while ethyl ether, $C_2H_5OC_2H_5$, is relatively insoluble. The three methyl and ethyl amines are soluble in ammonia in all proportions, *n*-propyl amine is soluble, di-*n*-propyl amine separates into two layers—a solution of di-*n*-propyl amine in ammonia and a solution of ammonia in di-*n*-propyl amine—while tri-*n*-propyl amine is less soluble than either of the other two propyl amines. The solubility relationships of the propyl amines in ammonia is very similar to that of methyl alcohol and methyl ether in water.

The solvent power of the amines has been examined to some extent.[7] One recalls that, in general, water is a very good solvent for salts but a rather poor one for carbon compounds (unless they contain a strongly polar union); ammonia on the other hand, although a good solvent for salt-like compounds, is a far better solvent for organic substances than is water.[8] Just as methyl alcohol is a poorer solvent for salts and a better solvent for organic compounds than is water, so methyl amine is a poorer solvent for salts and a better solvent for organic compounds than is liquid ammonia. Methyl amine, however, does not exceed liquid ammonia as a solvent for organic compounds to the same extent that methyl alcohol exceeds water for the same purpose, probably because the ammonia is itself a good solvent for organic compounds. Dimethyl amine is a poorer solvent for salts than either methyl or ethyl amine, while diethyl amine is a still poorer solvent for salt-like substances. Trimethyl amine, like dimethyl ether, is a very poor solvent for salts. In this connection, it is interesting to note that mercury, lead, and silver salts are more soluble in ammonia and the amines than in water and the alcohols.

It will be remembered that salts in alcohol solution are not so highly ionized as they are in water solution, while ether is a very poor ionizing agent. Furthermore, the ionizing power of the alcohols decreases as the number of carbon atoms in the molecule increases. The situation with the amines is strictly comparable. Methyl amine is a good electrolytic solvent but not as good as ammonia; solutions of salts in dimethylamine have about the same molecular conductivity as solutions of the same substances in ethyl amine; diethyl amine is a distinctly poorer ionizing

[7] Gibbs, *J. Am. Chem. Soc.*, **28,** 1395 (1906); Franklin and Gibbs, *Ibid.*, **29,** 1389 (1907); Fitzgerald, *J. Phys. Chem.*, **16,** 621 (1912); Elsey, *J. Am. Chem. Soc.*, **42,** 2080, 2454 (1920). Because of the unusual solvent power of the amines, they were used as solvents in the determination of the electrode potentials of the alkali metals. *Cf.* Lewis and Kraus, *J. Am. Chem. Soc.*, **32,** 1459 (1910); Lewis and Keyes, *Ibid.*, **34,** 119 (1912), **35,** 341 (1913); Lewis and Argo, *Ibid.*, **37,** 1983 (1915).

[8] THIS JOURNAL, **5,** 665 (June, 1928).

agent than any of those mentioned above. Similarly, solutions in the higher amines become progressively poorer conductors of the electric current as one passes up the series. The tertiary amines are distinctly not electrolytic solvents, no evidence of salts solution being found in any case and solvent in equilibrium with solid solute did not appreciably gain in conductivity.

Solvent of Crystallization.—Analogous to the familiar water of crystallization there are numerous compounds known which may rightly be said to contain ammonia of crystallization. Ammonia undoubtedly exhibits a greater tendency to unite with salts to form addition compounds than does water. For example, while $CaCl_2 \cdot 6H_2O$ is the highest hydrate of calcium chloride, $CaCl_2 \cdot 8NH_3$ is the highest *ammonate*. Corresponding to the hydrates, there are several salts with *alcohol of crystallization*: $CuSO_4 \cdot CH_3OH$, $LiCl \cdot 3CH_3OH$, $MgCl_2 \cdot 6CH_3OH$, $CaCl_2 \cdot C_2H_5OH$. Strictly comparable to these alcoholates are the even more numerous salts with amines of crystallization; $AgCl \cdot CH_3NH_2$, $LiCl \cdot 4CH_3NH_2$, $ZnCl_2 \cdot 4CH_3NH_2$, $CaCl_2 \cdot CH_3NH_2$, $CuSO_4 2C_6 \cdot H_5NH_2$.[9] There are even similar addition compounds containing ternary amines (ammono ethers) such as $BF_3 \cdot (C_2H_5)_3N$,[10] which are comparable to those compounds having ether of crystallization.[11] Although pyridine is strictly not an amine, it certainly has many properties of amines and attention should, therefore, be called to the numerous salts with pyridine of crystallization.

Metal Derivatives of the Amines.—One of the common reactions of the alcohols is that with sodium or potassium to liberate hydrogen and form substances of the type of sodium ethoxide (sodium ethylate); *e. g.*,

$$2Na + 2C_2H_5OH \longrightarrow 2C_2H_5ONa + H_2$$

The alkali metals react similarly with the amines although such reactions are by no means as vigorous as the reactions with the alcohols,

$$2K + 2CH_3NH_2 \longrightarrow 2CH_3NHK + H_2$$[12]

Other metal derivatives of the amines which have been prepared are CH_3NHCs, C_2H_5NHCs, $(CH_3)_2CHCH_2NHCs$,[13] C_6H_5NHNa, $(C_6H_5)_2NNa$, and others.

Nitridation.—Before proceeding with the final proof that the amines are to be regarded as ammono alcohols (or ethers) it seems advisable to

[9] Gibbs, *J. Am. Chem. Soc.*, **28,** 1395 (1906); Bonnefoi, *Ann. chim. phys.*, [7] **23,** 317 (1901); Lochowicz and Bandrowski, *Monatsh.*, **9,** 510 (1888); Elsey, *J. Am. Chem. Soc.*, **42,** 2080 (1920).

[10] Kraus and Brown, *J. Am. Chem. Soc.*, **51,** 2693 (1929).

[11] Cf. the work of Tschelinzeff on the ether and amine addition compounds of the Grignard reagent [*Ber.*, **41,** 646 (1908) and other papers].

[12] Titherley, *J. Chem. Soc.*, **71,** 460 (1897).

[13] Rengade, *Compt. rend.*, **140,** 246 (1905); **141,** 196 (1906).

digress for a moment to discuss the general topic of *nitridation*. This term is used to designate all those reactions which for the ammonia system of compounds are essentially similar to oxidation reactions for the familiar water compounds (ammono-oxidation) or for those reactions in which nitrogen plays a part analogous to that played by oxygen in the ordinary simple process of oxidation.[14] Early in the development of chemistry it was recognized that oxidation was a more general phenomenon than the mere addition of oxygen or removal of hydrogen (opposite of reduction) and the conception developed that oxidation is an increase in the positive valence (loss of electrons) of an element. Following experimental work which showed that certain electrolytic oxidation reactions could be carried out in a solvent containing no oxygen and similarly that certain electrolytic reduction reactions could be obtained in the absence of any hydrogen compound,[15] Cady and Taft,[16] in order to avoid these inconsistencies in the use of the terms "reduction" and "oxidation" in the broad sense, proposed instead "electronation" (the addition of an electron or electrons to an element) and "de-electronation" or "delectronation" as suggested by Browne. Perhaps this terminology is not the best but as yet no better has been proposed. According to this suggestion, oxidation, nitridation, etc., are to be regarded as particular types of a more general phenomenon, deëlectronation.

In the water system the number of oxidizing agents is large: nitric acid, potassium permanganate, potassium dichromate, potassium chlorate, chlorine water, and sodium peroxide being outstanding examples. Among nitrogen compounds the only two nitridizing agents to be examined to any considerable extent are hydrazoic acid (ammono nitric acid)[17] and a solution of iodine in liquid ammonia.[18] Other substances, notably sulfur and selenium,[19] have been shown to possess nitridizing properties and recently mercuric and bismuth nitrides have been added to this list.[20] In addition several electrolytic nitridations have been carried out in liquid ammonia.[21] That mercuric nitride is a nitridizing agent is not surprising in view of the fact that mercuric oxide is an oxidizing agent. The

[14] Browne and Welsh, *J. Am. Chem. Soc.*, **33,** 1728 (1911); *cf.* Goldberg, *Ibid.*, **34,** 886 (1912). Franklin, *J. Phys. Chem.*, **27,** 169 (1923); *cf.* also, Turrentine, *J. Am. Chem. Soc.*, **34,** 385 (1912).

[15] Cady and Taft, *J. Phys. Chem.*, **29,** 1057 (1925).

[16] Cady and Taft, *Science*, **62,** 403 (1925).

[17] Chuck, Dissertation, Stanford University, 1925. For a discussion of hydrazoic acid as an ammono nitric acid see ref. 2, p. 831.

[18] Strain, *J. Am. Chem. Soc.*, **49,** 1558 (1927); **50,** 2218 (1928); **51,** 269 (1929); Bergstrom, *J. Phys. Chem.*, **32,** 433 (1928).

[19] Bergstrom, *J. Am. Chem. Soc.*, **48,** 2324 (1926).

[20] Schurman and Fernelius, forthcoming publication.

[21] Ref. 13, p. 1070; Browne, Holmes, and King, *J. Am. Chem. Soc.*, **41,** 1769 (1919); Fulton and Bergstrom, Columbus Meeting, A. C. S., May, 1929.

following reactions will serve to show the great resemblances between hydrazoic and nitric acids as deëlectronizing agents:

$$Mg + 3HN_3 \longrightarrow Mg(NN_2)_2 + N_2 + NH_3$$
$$3Mg + 8HNO_3 \longrightarrow 3Mg(NO_3)_2 + 2NO + 4H_2O$$

$$H_2S + HN_3 \longrightarrow S + N_2 + NH_3$$
$$3H_2S + 2HNO_3 \longrightarrow 3S + 2NO + 4H_2O$$

$$Pt + 2HN_3 + 4HCl \longrightarrow PtCl_4 + 2N_2 + 2NH_3$$
$$3Pt + 4HNO_3 + 12HCl \longrightarrow 3PtCl_4 + 4NO + 8H_2O$$

Just as nitric acid when acting as an oxidizing agent is frequently pictured as decomposing thus:

$$HONO_2 \longrightarrow NO_2 + -OH$$

so may hydrazoic acid be pictured as decomposing in nitridizing reactions thus:

$$HNN_2 \longrightarrow N_2 + =NH$$[22]

Iodine reacts with liquid ammonia in a manner exactly comparable to the reaction of chlorine with water to form ammonium iodide (hydroiodic acid in ammonia solution)[23] and iodoamine (ammono hypoiodious acid):

$$NH_3 + I_2 \longrightarrow HI + H_2NI$$
$$H_2O + Cl_2 \longrightarrow HCl + HOCl$$

While the one is an oxidizing agent, the other is a nitridizing agent.

Much will be said throughout the present article concerning the nitridation of organic compounds. Let it be sufficient at this point to state that the ammono alcohols may be nitridized just as their oxygen analogs may be oxidized. Guanidine, an ammono carbonic acid, is formed when a liquid ammonia solution containing methyl amine and ammonium azide is heated for a time at 100°, and an abundant yield of cyanamide, another ammono carbonic acid, is obtained when, at laboratory temperature, iodine and methyl amine are brought together in liquid ammonia solution. Similarly, benzamidine (ammono benzoic acid) and phenyl cyanide (the anammonide of ammono benzoic acid) are formed by the action of iodine on benzyl amine, again of course in liquid ammonia solution.[24] The reactions involved are represented by the equations,

$$CH_3NH_2 + 3HN_3 \longrightarrow HNC(NH_2)_2 + NH_3 + 3N_2$$
$$CH_3NH_2 + 3H_2NI \longrightarrow NCNH_2 + 2NH_3 + 3HI$$
$$C_6H_5CH_2NH_2 + 2H_2NI \longrightarrow C_6H_5C(NH)NH_2 + NH_3 + 2HI$$
$$C_6H_5CH_2NH_2 + 2H_2NI \longrightarrow C_6H_5CN + 2NH_3 + 2HI$$

There is no case on record of the nitridation of a secondary ammono

[22] Schmidt, *Ber.*, **57**, 704 (1924).

[23] The ammonium salts are acids in ammonia solution; see THIS JOURNAL, **5**, 668 (June, 1928).

[24] Franklin, "Reactions in Liquid Ammonia," Columbia University Press, New York, 1927.

alcohol. Diphenylmethyl amine, however, when oxidized with bromine under hydrolyzing conditions is converted into benzophenone,[25]

$$(C_6H_5)_2CHNH_2 \longrightarrow (C_6H_5)_2CO.$$

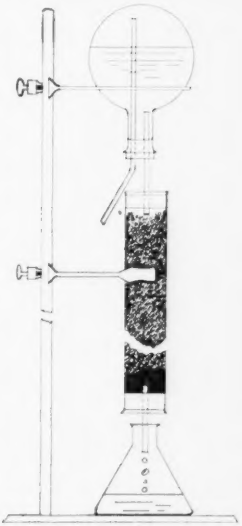
This reaction is simply the familiar oxidation of a secondary alcohol to a ketone. Undoubtedly, if this reaction were to be carried on under anhydrous conditions, an ammono ketone would have resulted.

[25] Hellerman and Sanders, *J. Am. Chem. Soc.*, **49**, 1742 (1927).

THE DECOLORIZING ACTION OF CARBON: A DEMONSTRATION

T. J. OTTERBACHER, ZION EDUCATIONAL INSTITUTE, ZION, ILLINOIS

An apparatus, which we have used very successfully for demonstrating the decolorizing action of carbon, is constructed from a one-liter round-bottomed flask and a glass tube 3.5 × 45 cm., which are fitted together as shown in the sketch. The bottom of the tube is fitted with a one-hole stopper containing a glass tube which acts as a drain and the tube filled to a depth of two or three centimeters with shredded asbestos. The remainder of the tube is filled with granulated charcoal. The top of the tube is also fitted with a one-hole stopper containing a glass tube which passes into the flask above, holding the liquid to be filtered. The stopper of this flask also contains a long glass tube which passes to the top of the flask and acts as an air intake.



Two sets of apparatus are used in the demonstration. One, with liquids such as cider vinegar, a weak caramel solution, brown sugar solution, or a very weak methyl violet solution, from which the color can be removed by filtering, and the other is filled with a solution of copper sulfate or some similar substance from which the color cannot be removed by filtering through carbon.

This demonstration has been found very efficient because its action is automatic as the lecture goes on and the student may see at the same time the color of the filtered and unfiltered solutions. It is best to start the liquid flowing a short time before the lecture hour so that the solution will have time to trickle down through the charcoal. Once started, however, the materials may be allowed to stand for several days by closing the drain with a piece of rubber tubing and a pinchcock.

DR. F. P. VENABLE'S CONTRIBUTIONS TO CHEMISTRY*

JAMES M. BELL, UNIVERSITY OF NORTH CAROLINA, CHAPEL HILL, N. C.

It is indeed rare when the faculty roll of a university includes the name of a professor who has been with the institution continuously for half a century. It is rarer still when during fifty years of continuous service to the cause of education, the professor has added to the sum of human knowledge in so many ways and in such eminent fashion. These contributions become more noteworthy when the professor has had to devote so many of his productive years to the guidance and general administration of the university. Such is the unusual record of Dr. Francis P. Venable.[1]

At the end of this academic year, he will have completed fifty years of active service at the University of North Carolina, during fourteen of which he was its distinguished president, laying the solid and stable foundations upon which its present reputation and standards have been built. It seems appropriate at this time that we should bear witness to the high qualities and review the achievements of the man.

Dr. Venable was born in 1856, and saw as a young child the armies of the Union and of the Confederacy passing through Halifax Court House, Virginia. After the war his father became professor of mathematics at the University of Virginia, and author of several famous textbooks in that subject. But Dr. Venable, or Frank as he was then known to his family and friends at Charlottesville, did not share his father's taste for mathematics, but preferred the natural sciences and the classics. For some time he was unable to make a choice between the two. Dr. J. W. Mallett, under whom he studied at the University, soon recognized the capabilities of the young student, and admitted him into his private laboratory, where he worked not only under Dr. Mallett's direction but under that of Professor F. P. Dunnington, who for forty-six years (1873–1919) was professor of analytical chemistry. It is interesting to note that during the time of Dr. Venable's studies at Virginia, Dr. Mallett was engaged in the determination of the atomic weight of aluminum, the results of which were accepted for many years as the best values for this constant. Only recently has the atomic weight been modified in the light of modern methods. Dr. Mallett put his students through a hard apprenticeship. One of Dr. Venable's first jobs was to distil water, allowing the drops to come from the receiver only at a determined rate. A couple of drops more or less each minute would not be tolerated. For days the young student held a watch in his hand and counted drops, increasing and decreasing the applied heat so that the drops fell according to schedule. Later a complete analysis of the mineral, livingstoneite, was required. The successful completion of

* Paper delivered before the Division of History of Chemistry of the A. C. S. at Atlanta, Georgia, April 8, 1930.

[1] See "American Contemporaries. Francis Preston Venable," *Ind. Eng. Chem.*, **16**, 755 (July, 1924); *cf.* THIS JOURNAL, **3**, 949–50 (Aug., 1926).

several of these painstaking tasks established the confidence of the professor in the student's patience and ability.

For a short period Dr. Venable taught in the high school in New Orleans, and then went to Germany to complete his work in chemistry at Bonn, Berlin, and Göttingen. There he met Dr. James Lewis Howe, now professor of chemistry at Washington and Lee University. The friendship which began in those days has continued, and it is always a pleasure to Dr. Venable to recount tales of student life at Göttingen in the society of "Lew Howe." In Germany he studied under the masters: Kekulé, Hübner, Clausius, Wallach, and Claisen.

In 1880 he was called to the chair of chemistry in the University of North Carolina. The University had been closed during the Reconstruction Years, 1868 to 1875, and was able to reopen in 1875 largely as the result of the efforts of the late Dr. K. P. Battle, who presided from that time until 1891. At once Dr. Venable began research in chemistry, some of the early papers appearing in the first volumes of the *Journal of the American Chemical Society*. In 1883, a group of young professors at this University organized the Elisha Mitchell Scientific Society, and began the publication of the *Journal* of this Society. The Society is still in flourishing condition and possesses a fine scientific library. Its *Journal* has acquired an international reputation. Each of the four or five young faculty members had his own scientific hero, from whose name a nickname was derived. The admirer of Sir Humphry Davy was called "Hump," the admirer of Count Rumford was called "Rump," the admirer of Michael Faraday was called "Mike." Dr. Venable was the Society's first president and for many years was its permanent secretary.

FRANCIS P. VENABLE AT THE TIME OF ACCEPTING THE CALL AS PROFESSOR OF CHEMISTRY IN THE UNIVERSITY OF NORTH CAROLINA

Dr. Venable has always insisted on the interrelationship of teaching and research. So that from the very beginning of his teaching, he has had a group of young students, undergraduates along with graduates, with whom he has been engaged at some research problem. At first the problems assigned to the students were relatively simple. It was during this early period that he devised a new form of Bunsen burner, the same in

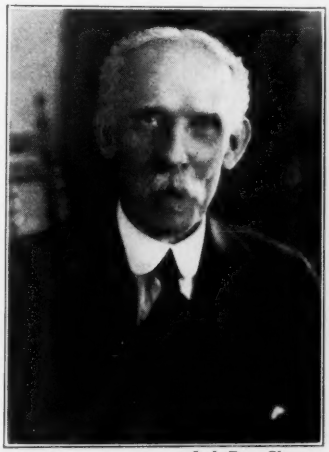
DR. VENABLE, ABOUT 1910, WHILE PRESIDENT OF THE UNIVERSITY

principle as in general use today. A picture of this burner appears in Volume 4 (1887) of the *Journal of the Elisha Mitchell Scientific Society*. He says in the article: "The main feature is that the supply of gas is regulated at the base of the burner by a milled wheel and that this supply is diminished only at the issuing jet inside the chimney." It is interesting to add that he did not then recognize the great money value of this modification of the burner, since for six burners he sold the right of their manufacture and sale.

Another important incident of this early period is his connection with certain experiments which were being conducted at Spray, N. C. It was here that the commercial method for making calcium carbide in an electric furnace was devised. Dr. Venable identified the material produced and recognized its great value. A dishonest associate, who later fled the country, robbed him of all financial rewards for the valuable work which he had done.

Dr. Venable is perhaps best known for his work on the element zirconium and its compounds. The earliest published work on this subject appears in the *Journal of the Elisha Mitchell Scientific Society* for 1891, and was done with J. M. Morehead, who has just recently become United States Minister to Sweden. In 1898 the atomic weight of zirconium was determined as 90.8, just two years before Dr. Venable was called to the presidency of the University of North Carolina. The onerous duties of this office permitted little time for laboratory investigations, and continually during this time he expressed regret at his inability to return to this problem, for he was convinced that the accepted value of the atomic weight of

zirconium was much too low. Practically all the experimental errors of the earlier method tended to make the value too low. After his resignation as president in 1914, he immediately returned to this study of zirconium. Dr. Venable and I then began a new determination of this atomic weight, using the methods which had been developed by T. W. Richards. The new values were over one unit higher than the former results, but duplicate determinations showed variations larger than we could explain on the basis of possible experimental errors. These variations were later satisfactorily explained by the discovery by Hevesy that all zirconium material contained a small quantity of a new element, hafnium. Some of our material was examined by Hevesy who found as much as 1% of hafnium in some of the samples. The atomic weight is now accepted by all as 91.2. This last rectification of the atomic weight confirms Dr. Venable's contention that the early results were uniformly too low. He has in recent years crowned this work with a very excellent monograph on zirconium,[2] one of the series of monographs published by the American Chemical Society.



Ind. Eng. Chem.

DR. VENABLE, IN 1925, THE YEAR OF THE DEDICATION OF VENABLE HALL OF CHEMISTRY

In reviewing the list of the numerous publications of Dr. Venable, I find many titles pertaining to the atomic weights of the elements, to the standards for the atomic weights, to the arrangements of the elements, and to the pedagogic uses of the periodic arrangement of the elements. An early paper[3] contains arguments in favor of the adoption of oxygen = 16 as the standard of atomic weights, substantially the same arguments appearing in a later paper by Brauner. This interest in the orderliness of nature was of such import and interest to Dr. Venable that he published his well-known work on the "Periodic Law"[4,5] (1896), formerly used as a textbook in many colleges and universities. This book has had a very great influence, pointing out clearly and concisely the reasons for believing that the different kinds of atoms are related in an intimate way.

[2] "Zirconium," Chemical Catalog Company, New York City, **1922,** 173 pp.

[3] *J. Elisha Mitchell Scientific Society,* **5,** 98 (1888).

[4] "The Development of the Periodic Law," Chemical Publishing Co., Easton, Pa., **1896,** 321 pp.

[5] "The Study of the Atom," Chemical Publishing Co., Easton, Pa., **1904,** 290 pp.

This interest in the orderly relationships of the elements could not but accompany an interest in the development of chemical theory in general. In fact the book on the "Periodic Law" was preceded by another volume called "A Short History of Chemistry."[6] Who of the older generation is not familiar with this book? It was for years the only text in English on the history of chemistry, and it has even yet not been entirely superseded by more recent works on the subject.

With the passage of time the prevailing views regarding atoms have undergone change, and we find Dr. Venable eagerly following these new developments. In 1917 he prepared a small book entitled "A Brief Account of Radioactivity,"[7] intended to supplement the texts on general chemistry, many of which at that time scarcely mentioned radium and the influence which the study of radioactive bodies has had on general theory. Besides these books, he is the author of "Qualitative Analysis"[8] of which there were several editions, and of a book on "Inorganic Chemistry"[9] (with Dr. J. L. Howe) based on the periodic arrangement of the elements.

It has been an unusual privilege to have been associated with Dr. Venable these twenty years. Like all the great in the scientific world, he has insisted on the establishment of facts beyond doubt before permitting any but limited speculation or theorizing, he has been a liberal conservative in chemical theory, adhering to the accepted theories until better theories were proposed, but willing to adopt well-considered ideas with solid experimental bases.

Any outline of Dr. Venable's career would be incomplete if mention were not made of several of the honors which have come to him. He was President of the American Chemical Society twenty-five years ago, president of several educational associations in the South, recipient of honorary degrees from the University of Pennsylvania, the University of Alabama, the University of South Carolina, and Lafayette College. The University of North Carolina has done itself the honor of naming its new chemical laboratory "Venable Hall,"[10] and will do itself the honor of conferring an honorary degree on Dr. Venable when he retires from active service in June, 1930. These honors recognize his eminent qualities in authorship, research, and administration.

[6] "A Short History of Chemistry," D. C. Heath and Co., 50 Beacon Street, Boston, Mass., **1894** (3 editions), 163 pp.

[7] "A Brief Account of Radioactivity," D. C. Heath and Co., 50 Beacon Street, Boston, Mass., **1917,** 54 pp.

[8] "A Course in Qualitative Chemical Analysis," New York University Publishing Co., New York, N. Y., **1883** (4 editions), 53 pp.

[9] "Inorganic Chemistry According to the Periodic Law," with J. L. Howe of Washington and Lee University, Chemical Publishing Co., Easton, Pa., **1898.**

[10] For an abstract of the dedicatory address delivered by the late Edgar Fahs Smith, see THIS JOURNAL, **3,** 946–9 (Aug., 1926).

LECTURES AND LECTURE EXPERIMENTS*

A. W. Davison, Rensselaer Polytechnic Institute, Troy, New York

At the present time, there are four common methods of instruction which are available for presenting chemistry. These are: home study, lectures and lecture demonstrations, recitation or quiz periods, and laboratory work. One of the outstanding problems which confronts the chemistry teacher is: Just how much time should be allotted to each of these four divisions in order that the student may obtain the maximum benefit from his course? In the early days this question did not appear for it was perfectly obvious then just how the student should go about it to receive instruction. Textbooks were not available, laboratory resources were meager, and it was therefore necessary for him to become attached to a master for verbal instruction and for direction in laboratory procedure. Nor was laboratory practice the minor part of his program; it contributed very largely to the education of most of our early chemists.

The development of the laboratory method for teaching science has been one of the significant contributions of American education. Although some of our schools and colleges have allowed themselves to overdo it somewhat, the method is sound, and it has a permanent place in our educational systems. It is the ideal way to present chemistry, but our science has now become so complex, and so many facts have been collected, that we are no longer able to turn a student loose in the laboratory and permit him to find things out for himself. We are compelled to not only carefully guide his endeavors while he is engaged in laboratory practice, but to cast about for some method for supplementing the experimental work which he cannot find time to do.

Since science has become so complex, and since textbooks of merit are now so readily available, the present tendency in many of our American colleges is to swing away from formal lectures and laboratory work toward increased home study and added recitation periods. Many of us wonder where this tendency should be arrested, and all of us, I am sure, are seeking a just balance between the four types of study which will give adequate opportunity for experimental evidence, for the systematic classification of knowledge as presented by the experience of the past, and for the inspiration and time-saving which follow from proper presentation of the subject through lectures and lecture demonstrations.

Now it is very obvious that conditions, traditions, educational policies, facilities, and even types of student raw-material vary widely from one American institution to another. To attempt, therefore, to lay out a schedule which will prove a panacea for the particular needs of all of us is impossible. The best we can hope to do is to discuss in a broad way the

* A talk presented before the Symposium on Chemical Education at the regional meeting of the Chemical Society at Schenectady, December 7, 1929.

relationships between the various types of work which a student may perform, and then proceed to apply the principles so developed to the particular requirement of the institution in which we are laboring.

There is little doubt that the four tools of instruction which I have enumerated are all highly desirable and necessary in a well-balanced course in any of the branches of chemistry, except possibly in certain of the advanced and purely theoretical subjects. As a starting point, therefore, one might do well to lay out a system of time distribution and determine whether this meets the present-day needs of our sciences. It seems to me that the following scheme makes a very satisfactory one, and indeed I have found that many institutions are giving their courses in chemistry on slight modifications of this plan. Home study, 2 hours; lecture demonstration, 1 hour; recitation period, 1 hour; laboratory period, $2^1/_2$ hours. On looking over existing curricula, one finds that the particular methods of giving instruction in various institutions call for one lecture, one recitation, and two laboratory periods per week; or two lectures, two recitations, and one or two laboratory periods per week—all of which is in line with the scheme I have heretofore outlined.

Whatever system of time allocation is followed, the character of the lecture presentation and experimental demonstration should not be compromised. In many institutions, it has been my observation that the success of a teacher rises or falls entirely upon the type of lecture which he gives in his courses. This is particularly true in the Arts College, where science courses are elective. If an instructor is anxious to build up the student personnel of his department, his opportunity comes in his lecture and demonstrational work. If he is to succeed in attracting students to his courses, he must win them by the merits of his lectures. It would be fatal even in our engineering schools, where courses of study are largely prerequisite, for an instructor to overlook the possibilities of the lecture and lecture demonstration, for even here a teacher is judged, if not by the number of students whom he attracts into his courses at the immediate present, at least by the quality of the graduates he turns out. I have come to the conclusion, therefore, that it makes very little difference in what type of institution one happens to be located, his real opportunity in presenting chemistry so that young men or young women can have excellent courses in the subject comes in the lecture room, through the preparation and delivery of excellent lectures and outstanding lecture demonstrations.

It might be well at this point to digress long enough to give a brief discussion on the general requirements for a successful lecturer and lecture demonstrator. After an experience of about twenty years in teaching chemistry, it has recently occurred to me that it does not make much difference whether one understands the fundamental principles of pedagogy as such or not. The thing which does matter is that the lecturer be a thorough

master of his science; that he possess enthusiasm; and that he have the ability, the adaptability, and the personality to sell his ideas and his knowledge to other people. We have all many times encountered masters of the art of chemistry who are not able to teach it, simply because they do not possess the personality to put the subject across to students in an attractive manner. And in the same way, we all know teachers who are not particularly outstanding in their field as scientists and yet who are able educators because of their ability to impart what knowledge they do possess. It seems to me that personality is one of the greatest factors in the make-up of the successful teacher. A man or woman who possesses personality and the ability to impart knowledge to others certainly understands the fundamental principles of pedagogy, even though he may not be conscious that he understands them.

Now let us inquire whether there exist variations in the attitudes and capabilities of students which may be overcome by the lecture-demonstration method. Whether we like to admit it, the fact remains that students are divided into three distinct classes. First comes the chap who is deeply interested in chemistry; who has innate ability, and who will work to the limit to master the subject. Although students of this type are bound to succeed regardless of the character of their instruction through their ability to find things out for themselves, they cannot fail to call forth the best efforts on the part of their instructors. Then there is the second type of student, the man who has ability, but who has been thrown into chemistry through no choice of his own, and who must have inspiration if he is to do anything with it. He is the man who is the greatest incentive to the teacher. It is a fact that we all hope to be able to pass the maximum number of students taking our courses; rarely do we take pleasure in failing a person. It is truly a source of pleasure, when one sees a man come into his courses listlessly, to succeed in inspiring him to do excellent work. To be able to do this gives one a sense of justification for being in the teaching profession. Then there is the third type of student who neither possesses the ability nor the inclination to get into his subject. This fellow is usually the boy who has come to college because it is being done, or because he wants to play football, or because he wants to postpone going to work as long as possible. There is no need for a teacher to butt his brains out against a stone wall, and the sooner he can recognize this third man in his classes and forget about him the happier he will be.

What shall we say with regard to the character of lecture experiments? I feel that it is not within the province of this paper—the purpose of which I believe is to stimulate discussion—to cite the specific experiments which may be performed. There are so many examples of suitable experiments in the literature and in the textbooks, and so many of us have our own pet numbers which we think we can do better than any one else, that it would

not be fitting to discuss them here. It seems to me that we had therefore better stick to generalization, and as I look over the subject, there are a few fundamental precepts which we can safely adopt as our guide in laying out such experiments as are suitable to be performed before classes in the various special fields of chemistry. In the first place, the experiment should be of such a character as to make it possible for every student in the room to see it plainly. As a second consideration, such experiments should be selected as do not require too much time for their completion. Nothing is so fatal for the demonstrator as to have a lax period in his presentation, during which the class may become restless, and during which he may lose its undivided attention. A third possibility which we should not overlook is the inclusion of many experiments of a spectacular nature. I call attention to this on account of the great value which this type of experiment has in stimulating interest on the part of lukewarm students. One of the most successful teachers of general chemistry whom I have ever had the privilege of observing employs a large number of spectacular experiments executed with a great deal of skill, and I have always attributed his success, in part, to his ability to do this very thing. One should, however, not permit his enthusiasm for the spectacular to run away with him; neither should he permit himself to give a cheap vaudeville performance under the guise of teaching chemistry.

It seems to me that there can be no question as to the desirability and the necessity for adequate lecture time and for well-performed lecture experiments. If a lecture demonstration gave nothing but inspiration to the student, it would be well worthwhile, but the inspirational value is only one of the minor benefits to be obtained from a properly conducted lecture demonstration. Students in general have to be told what to study and how to study it. This may very well be done in the following manner —a scheme which I have followed with success for a great many years. Announcement is made on the day preceding the lecture showing just what ground will be covered, and the student is expected to read over this matter in the text. He is thereby prepared to understand the lecture when it comes along and, particularly, to detect the significance of such experiments as are performed for him. After the lecture he is given an opportunity to go over the work more carefully in home study, paying particular stress to those portions which have been pointed out as being most significant. The following day he comes in and recites. Our recitations have a threefold purpose; first, to enable us to give the student a "mark" on his daily work, second, to make certain that he is doing this work day by day, and third, to enable the instructor to clarify troublesome portions of the assignment by means of what amount to small-group conferences. The laboratory period which follows the theoretical work is concerned of course with the nature of matter which has been covered in the lecture and in the recitation.

One of the important things in laying out a suitable course of lectures is the selection of the textbook which is to accompany them. It has always seemed to me that the lecture material and the text material should coincide very closely in freshman and sophomore work, on account of the fact that men of these grades are not, as a rule, capable of taking adequate notes. It doesn't matter so much in the junior and senior years, but in the freshman and sophomore grades one should select a text which is well adapted to the type of lecture he proposes to give. Now there are a great variety of textbooks in chemistry—some good, some excellent, some mediocre, some poor—but at the present time it is certainly possible for any teacher to find some text which very nearly coincides with his idea of what a course should be.

I presume all of us have known excellent chemists and excellent teachers who are so temperamentally or so physically constituted that they cannot perform a lecture demonstration before a class. Such a man is, in my opinion, only qualified to teach seniors and graduate students. He certainly has no place in the lower grades of undergraduate work. Many of us have at various times observed teachers who were too lazy to outline and prepare adequate lecture demonstrations; and lecture demonstrations certainly do take time in their preparation. Such a man is not worthy of a place on the faculty of any American college. There are other men who do not believe that lecture demonstrations are of any material value. These men should adjust themselves to the modern viewpoint of teaching chemistry, which calls for inclusion of all four of the available methods.

In closing, I would like to make the following observation. If I had my choice of only one of the four methods for presenting college chemistry, and if I were attempting to give a student a comprehensive understanding of the science, I believe the lecture demonstration would be my selection, for I feel that such facts as might thus be presented to him would remain with him longer than would those which he would be likely to secure from any of the other methods. And if I were to be limited to only two of the four methods, I should choose the experimental lecture and the laboratory period.

Magnetism and Heating Hardens Metals Alike. Metals can be superhardened by magnetic treatment as well as by heat treatment, E. G. Herbert reports before the Iron and Steel Institute.

Magnetic hardening is accomplished by repeatedly changing the polarity of the steel, Mr. Herbert explains. A specimen so treated could not be hardened more by low temperature annealing, he says.

Whether the magnetic treatment is apt to become of commercial value is not indicated. It is evident that both magnetism and heating doubtless produce the same atomic rearrangement. This phenomenon may lead to the finding of additional information about the structure of magnetic metals.—*Science Service*

TWENTY YEARS OF EXPERIMENTING IN TEACHING COLLEGE CHEMISTRY*

HERMAN SCHLUNDT, UNIVERSITY OF MISSOURI, COLUMBIA, MISSOURI

For twenty years our introductory college course in chemistry has embraced classroom work (lectures, recitations, quizzes, demonstration experiments) and laboratory work by students. A standard college textbook and a laboratory manual have always been required. The manual now used requires no notebook for laboratory record. Experimental data are recorded on blank pages of the manual: and answers to questions in the manual are recorded in the space provided. A notebook, however, is kept by the student for filing classroom exercises. Notes on lectures are not required, but students mark passages in the text as the lecture proceeds.

The course has always been on a five-hour basis, with three lectures per week and two laboratory periods of two hours each. The full course extends over two semesters, the total credit being ten hours. For ten or perhaps twelve years, an additional conference period has been required, bringing the total hours of attendance by the student in classroom and laboratory up to eight hours per week. The assignments for homework probably require about six hours per week of work outside the classroom, making a total of about fifteen hours per week of student application.

The additional conference period was the result of a request by students following an experiment with a small group in the summer session. The conference groups are small—twelve to eighteen students, and are conducted by the students' laboratory instructors. It is a period for study and drill in working problems. Each laboratory instructor attends one of the class lectures, and thus coördination between class and conference work is maintained.

Laboratory Work

Laboratory work is conducted in small laboratories, fifteen to eighteen students in each section, supervised by one instructor. Individual laboratory work is the rule. Each student is supplied with locker and individual equipment, but has no reagent bottles on his table. One side shelf for reagents, centrally located, suffices for each room. Quantitative experiments are emphasized, and are required to be performed in duplicate: *i. e.*, a first and a second trial. Several unknowns are introduced: for example, under specific heat, the student is given a metal bar of unknown composition; the percentage of water in an unknown hydrate is assigned; in neutralization, the normality of a base and acid is determined. Each student in a section is furnished a different sample. This feature of laboratory work, it seems to me, can be extended even to the experiments of the first semester. It has been given more prominence in our work within the past three years.

* Presented at the meeting of University of Missouri Section of A. C. S. devoted to the Teaching of College Chemistry, December 6, 1929.

Filling out answers to questions and problems in the laboratory manual involving ideas closely related to the experiment, has distinct advantages. The student always brings the textbook to laboratory and refers to it frequently, thus securing better coördination between the two phases of work. Incidentally the student is compelled to study the text. No time is spent in copying directions from laboratory manual into notebook. The time usually so spent by the student is put in looking up answers to questions. All laboratory notes are made by the student during the laboratory period, and these notes are made in duplicate—a carbon copy being given the instructor for correction and record. This is the second semester we are experimenting with this system of laboratory notes.

Our laboratory instructors find that the lack of skill in arithmetic has retarded laboratory experiments materially. To remedy this, in part, we spent about two weeks at the beginning of the term in reviewing arithmetic, under the head of the metric system, but including the computation of large and small numbers, decimals, positive and negative exponents, etc.

Classroom Work

As I look back to my early program for lectures, it seems to me that the greatest transformation in the character of the instruction has taken place in this phase of the course method. The transition has been gradual, and each new year sees a series of changes. We have not even now evolved a standard system although the high points in the course remain unchanged. Our lecture classes have ranged in numbers from thirty-five to one hundred seventy-five. With the larger sections, several instructors are present. They help the students in the written work, which has now become a daily part of the classroom period.

Having served for a time during my early years as lecture assistant in general chemistry, I had a fondness for lecture demonstrations as a means of arousing interest, and as the best method of imparting knowledge of chemical phenomena. I had also carried away with me the many vivid scenes from the attendance at a course of lectures in general chemistry given by an eminent German professor, whose hobby evidently was elegant lecture demonstrations. This veteran performer, assisted by well-trained helpers, now and then said that the ideas we get by reading may soon be forgotten, but those things which are seen will always be remembered.

My experience, however, has convinced me that ideas gained through visual methods fade away very readily from freshmen. During the early years of this teaching experiment we probably introduced too great a variety of experiments. There is a real danger here of bewildering the student. In the first place, he will not differentiate between such demonstrations as are basic, and those that are mere pleasing incidents. Again, the experiment, without full discussion, may get but little beyond the stu-

dent noting a smoke, an explosion, a stink. Gradually, as the years have passed, we have reduced the number of lecture experiments, centered our attention on the more basic demonstrations, and elaborated the experimental equipment by not infrequently repeating the experiment with modified apparatus. For example, the decomposition of water by electrolysis is repeated at least four times with four different types of apparatus, but each piece of apparatus is brought to the attention of the class at different stages in the course. A student or two always assist me with certain parts of the experiment and with the equations for the reactions demonstrated. The burden of any necessary blackboard writing is always delegated to a student. This method takes more time, but the compensation is a higher index of attention by the class.

Exhibits are for the most part materials or apparatus which are being used in the demonstrations. Of course, we all have experiments go wrong, but this must be a rare occurrence, indeed, for experimental "set ups" which show the principle but fail to function properly, are now considered jokes by students. Demonstrations in order to be effective must be carried out with skill, and the experiment must work.

Demonstrations follow assigned readings as a rule. In our early years we lectured and demonstrated profusely, day after day, assigned readings and problems for homework, and then after a month announced a written quiz, for which the student crammed diligently. Only the conscientious, independent workers of the assigned problems maintained any sustained daily preparation. Now we have daily recitations, and by sustained repetition manage to force the class average on a one-hour written quiz up to 60 and even 65, which is not so bad considering the fact that the graders (in this case, graduate assistants and instructors) scale down severely for mistakes.

Repetition has become the watchword of our efforts in class instruction. The number of topics now included looks greatly reduced in comparison with our earlier attempts, but far more emphasis is being placed on the topics studied. The present course is a far more intensive course, intensified by repetition of basic ideas. At the very outset, the law of multiple proportions and the law of combining weights have been set aside. The chemical equation, with all the wonderful array of facts it shows when it finally receives the touchstone of the molecular theory, is made the first cornerstone in our program. Then comes the idea of concentration—in terms of moles; and following this the relation between electricity and chemical change—the close relation between electricity and matter including valence, which culminates through the discoveries in radioactivity in the structure of the atom. This sequence is unfolded in connection with a study of a few typical elements and compounds: oxygen, hydrogen, water, hydrogen chloride, sodium hydroxide, chlorine, sulfur, the alkali and alkaline earth metals.

Daily Written Tests and Monthly Quizzes

A glance at one of the class record books for this semester shows that we have already recorded about forty grades for each student. Three one-hour quiz grades are also recorded. We are able to keep these records by having an adequate force of problem readers. Each day ten to fifteen minutes of the class period is taken for written work. The questions are framed in such a way that the papers can be quickly corrected by the student problem readers. Two sets of papers are passed out; these are handed in, and the student on the way out takes a copy of the other set, which he hands in at the next meeting of the class as a part of his homework assignment. These papers are graded and returned at the next class period. Students file these papers away in a notebook. From these daily questions the monthly set is assembled.

Fundamental concepts are taught by repetition, for after all learning to read is the test of progress and achievement. A critical examination of the simple questions on the daily tests will reveal that a mastery of the text-book language and terms is absolutely demanded. To acquire this real understanding the process of repetition is made the keynote of our efforts. For example, the sheet on the physical properties of chlorine is a repetition of the points stressed in the chapter on changes of state. Students may use their books on the daily quizzes, but not on the monthly quizzes.

An examination of these written exercises will show that only a small part of the student's time is used in the mechanical recording of his answers. True and false, multiple choice, blanks, problems, and equations make up the questions.

Concert reading of blackboard exercises is introduced occasionally.

Semester Grades

In making up the semester grades, the laboratory work counts 25, the final 25, and the class and quiz work 50 points, to make the numerical value on the scale of 100. A rank sheet is then prepared and is usually found to approximately coincide with the probability curve. The grades assigned, in rough, conform to the rules for grading now in force in the university: *E*'s less than 5%, *S*—20%, *M*—50%, *I*—20%, *F*—5%. Our *F* mortality is considerably higher when students drop out for failure after the six weeks' trial.

This year we are trying to salvage more freshmen by holding two extra sessions per week for flunkers. A grade below 50 on a monthly quiz is considered a flunk; fully one-third of our class of 350 students fall in this class at mid-semester. Reasons for this high percentage of deficient students are: (1) the courses may be pitched on too high a level; (2) inadequate high-school preparation; (3) lack of ability—*i. e.*, low I. Q.; (4)

poor habits of study; (5) laziness, lack of application, ability not utilized; (6) system of instruction fails to make an appeal.

Sectioning

In this connection, the question comes up, should we segregate these "low graders," and give them a course in chemistry more descriptive in character; including something about chemistry and its applications—pandemic chemistry as Bancroft has termed it? Why expend the instructor's time on these students and thus overlook the gifted student? Would it not be a more efficient plan to give these students a different type of course in which memory work predominates, and containing very few problems? We are still of the opinion that the struggle of the students with the principles is worth more to him than fostering smattering, and perhaps developing still further his inferiority complex by the very act of segregation.

Students in general chemistry are not sectioned now on the basis of previous training. About 35% of the students in general chemistry have had a course in high school, but we find that only a few of these will take advantage of the option of enrolling for the work of the second semester. About 10 years ago, we separated sections for students who entered with high-school chemistry. Now we differentiate only in the laboratory work, and even in that but slightly. Recognizing that some duplication exists we reduce the credit from five to four hours for those students having had a high-school course.

My observations have convinced me that the duplication which exists does not represent a loss of time in the education of the student in chemistry. In the first place, the lecture demonstration feature of the college course has received but limited attention in the high-school course. Then, too, the college course marks quite an extension of the basic principles. Thus the student with high-school training is not simply marking time when he takes the college course in general chemistry.

Will of William H. Nichols. According to *Science*, the will of the late WILLIAM H. NICHOLS, chairman of the Board of the Allied Chemical and Dye Corporation, bequeaths $1,000,000 to public purposes. Half of the residuary estate is left to New York University for the maintenance of the Nichols Chemical Laboratory, which Mr. Nichols gave to the institution in 1927. He served as acting chancellor of the university last spring and fall during the illness of CHANCELLOR BROWN. It is requested that the bequest be used to keep the laboratory "at all times in good order and repair and well equipped." The largest institutional legacy is $250,000 to the Polytechnic Institute of Brooklyn. Mr. Nichols attended that school for three years in his youth and was vice-chairman of its board. The American Chemical Society and the American Society for the Control of Cancer each receive $50,000.

TRAINING HIGH-SCHOOL CHEMISTRY STUDENTS TO DRILL THEMSELVES

BRUCE F. LAMONT, HAZLETON HIGH SCHOOL, HAZLETON, PENNSYLVANIA

No feature of high-school work requires more thought than the aim and character of drills and review. In drill work we attempt to make association or skills automatic, and in reviews we reteach old material with the aim of getting a new view or of gaining new associations. In the study of high-school chemistry there is constant need for repetition of ideas at properly timed intervals; acquisition of new terms, writing formulas and equations, and chemical problems all demand frequent drill.

Our outstanding aim in all drill work is to get high-school pupils to learn to drill themselves. The inability of high-school pupils to do this is undoubtedly an outstanding weakness of all high-school instruction, resulting in untold failures on the part of first-year college students. High school is the place where students should be taught correct habits of drill.

If we can get high-school pupils to drill themselves so that the response desired becomes automatic, we shall be placing in their hands the means of securing mastery of subject matter. In many instances at the end of a high-school course pupils fail to display the thorough knowledge of a subject that we teachers desire. Lack of interest on the part of students is frequently due to incomplete mastery of the subject. If we can instil habits of self drill, we overcome the pupil's lack of interest, and mastery of subject matter will result.

In his classes in chemistry, the writer places in the hands of his pupils at the beginning of the school year mimeographed copies of what he terms "Basic Requirements in Chemistry." The subject matter is divided into nine units as follows: (1) definitions; (2) laws and theories; (3) preparations and properties; (4) industrial processes; (5) tests; (6) equations; (7) experiments; (8) formulas for common substances; and (9) problems. Under these topics the actual fundamentals are listed. It is not a mass of detail, but just the very essential ideas of the subject. At the conclusion of each unit is the statement: "the student, in order to make a passing grade, is expected to know, without error, these requirements." It is this statement and the insistence with which the teacher holds the pupils to the fulfilment of the requirement that brings results. It must not be understood that this is the order in which the content is studied. The purpose of it is purely for drill and review. A little tactful and sympathetic discussion of the requirements will convince pupils that their work will be made easier; anyway it will be more definite and specific.

However, the use of such a scheme as basic requirements does not necessarily mean that our teaching aim is the acquisition of facts. Facts, though, must be acquired before the pupil can be taught to think in terms of chemical principles. The mimeographed copies of the basic requirements state the objectives of our course as follows:

1. To see that the requirements of the basic facts are so well learned that mastery will result.
2. The acquisition of these facts will better enable the student to appreciate science in the service of civilization.
3. To overcome the pupil's reluctance for further reading in science.
4. To help pupils to discover whether they have an aptitude for further study in chemistry.
5. To encourage students to keep notebooks containing an accurate record of work done.
6. To bring the other sciences into close relationship with chemistry.
7. To train in the scientific method.
8. To show the service of chemistry to the home, to health, to medicine, to agriculture, to industry—in a word, to show the service of chemistry to civilization.

By means of frequent tests, the pupils are brought to a realization of their lack of mastery and their need for the acquisition of the association to be taught. These tests not only show the pupils the need for further drill, but serve the purpose of diagnostic tests. By classifying the content into units and insisting upon the students knowing these essentials without error, their weaknesses are definitely pointed out to them.

In using this method we are placing in the hands of the student definite and specific material which is to be mastered. The student knows definitely what is to be done. The zeal and interest of the student is usually aroused because there is a challenge.

The teacher takes time to explain the laws of drill and habit formation. High-school students are old enough to understand and appreciate the learning process. Frequent sympathetic talks by the teacher keep up enthusiasm, and the urge to master the fundamental principles listed in their basic requirements.

A device like this, besides being an aid to students in drilling themselves, serves to motivate the work. They know definitely what is to be accomplished and they set about doing it with zeal and interest. For they know that in order to secure credit they must pass without error all items listed in their basic requirements.

Frequent class reviews are held, but here the aim is to re-teach old material in a way so as to form new associations, and thus get a new view. These reviews supply a background for the students' drill work. They present the old material which is to be acquired by drill with a new view; correlating all facts where possible, and thus provide new associations making the drill work on the part of the student somewhat easier.

Most content subjects lend themselves to a division of subject matter into units, and under these units can be classified all essential facts. By holding the pupils responsible and insisting that they know these facts, without error, teachers, I believe, will undoubtedly find self-improvement on the part of their students. It tends to secure accuracy of detail and expression, aims are clarified, the work is motivated and becomes more definite and specific.

A BEGINNING COURSE BASED ON THE PRINCIPLES OF CHEMISTRY

ERNEST E. BAYLES, UNIVERSITY OF KANSAS, LAWRENCE, KANSAS

New ways of doing things, if they are better ways, are in constant demand. Oftentimes, however, new ways are demanded whether they are better or not. There is a rather insistent demand for revision of the high-school chemistry course, possibly for the latter reason, but more probably for the former.

In this article is presented the outline of a high-school chemistry course which is decidedly different from the one usually offered, and which, it is hoped, is somewhat of an improvement.

Before organizing any course, those concerned must first have a clear realization of the end or purpose which the course is to achieve. The principal purpose of the high school has been variously defined as preparation of the citizen; that is, preparation of the average man, or of the layman. This individual, outside of his own vocational preparation, requires a generalized notion of the basic, governing principles which underlie the various aspects of his environment. He must be introduced to these principles, and that thoroughly enough that he will recognize and apply them when occasion demands. The course must be designed to give him probably the only systematic view of the science of chemistry that he will obtain. It may, of course, enlist his interest and lead him to follow up chemistry as a vocation, but in most cases it will not. The course must be adapted primarily to the student who will not go farther into the subject.

This type of student needs a course that will do two things. He needs first a "speaking acquaintance" with the common, every-day facts, ideas, and nomenclature of the subject in order to become conversationally intelligent regarding it. This will enable him to take an active part in discussions with his fellows and to read intelligently on matters dealing with chemistry. He needs, in the second place, to be able to apply the principles in the solution of every-day problems as they appear. New problems are always arising. The uninitiated is at a total loss in facing them, but not so the one who can classify the problem and from this classification can deduce the solution. It is the primary purpose of the high-school chemistry course to establish a familiarity with things chemical, and a comprehension of the governing laws and principles.

Not only the proper purpose of the course, but also the proper method of accomplishing this purpose must be realized by the ones who make the course. If principles are to be understood, the course must be organized around these principles. The principles of chemistry, not the facts of chemistry, must determine the topics around which the discussions must revolve. Two questions immediately present themselves. First, what

shall be the order in which these principles are presented? Second, what shall be the method of presentation?

The modern newspaper reporter recognizes the need of the busy man for getting the greatest amount of information regarding daily happenings in the least possible time. This is efficiency as demanded today. The first paragraph of each article embodies the essential points that are presented in the entire article. The later paragraphs are an elaboration of the first. They go farther and farther into detail. This same principle of organization should be followed in the beginner's course in chemistry. The first unit should cover the field, and each subsequent one should serve to elaborate, in greater and greater detail, the first. The order of topics in the course must be from the more generalized to the more specialized. The first unit in the following course is entitled "The Nature of Chemical Changes," but each and every subsequent unit also deals broadly with this same topic, the only difference being that special features are singled out for more detailed study as the course proceeds.

The internal organization of each unit must embody the inductive approach and the deductive departure. This is the way man first discovered these laws, and it is the most effective way to teach them. Seemingly unrelated phenomena are brought to the student's attention and his interest enlisted in making an explanation which makes clear the relationship. Comprehension comes with the realization and verbal formulation of this relationship, and the test for comprehension is secured through the application of the principle to the solution of novel problems which involve the relationship. Thus, it is seen that chemical facts are needed in the course, but as means rather than as ends. Any group of facts which serves to illustrate the relationship under consideration will be satisfactory. Those facts which statistical investigations show are most likely to reappear in the future experiences of the learner should be the ones most commonly used, but they are not the only ones that could be used. The relationships are essential, the facts are incidental.

The following outlines present approximately two-thirds of a course in high-school chemistry in which an attempt has been made to follow out the above ideas in course organization.

The basic principles of the subject are the unifying factor. They are taken up one at a time and the student is expected to master each one before he proceeds to the next. Outlines are only partially satisfactory as a means of showing a method of organization. The reader must use his imagination in filling in the gaps and noting how one topic leads into the next. Each major division of the course is devoted to one of the major principles of chemistry, and is designated by the term "unit."

No attempt is made to present to the student systematically a detailed list of chemical and physical properties of the various elements and their

compounds. In an incidental way he will become acquainted with many of these in the course of the year's work. In teaching the course, the attempt is continually made to bring the student into direct contact with as many substances as possible so that he will have the "feel" of them, and will know them through contact rather than through description. Experiments should be selected solely on the basis of their effectiveness in illustrating the working-out of the principle under discussion.

The course has been used in high-school classes with a number of different teachers, and has shown itself to be practical and teachable. It leads the student to see chemistry as the science of the behavior of substances, the comprehension of which will develop to him the ability to foretell what this behavior will be. It will lead him to make his own activities intelligent rather than of the trial and error sort. The essential end of science is the prediction of behavior. This should be the primary end that the chemistry teacher seeks to achieve.

Unit I. The Nature of Chemical Change

1. *How to distinguish between chemical and physical changes.* Gleaned from the observation of chemical and physical changes in the home and in the laboratory.

2. *How chemical changes act in accordance with certain laws;* such as the Law of Conservation of Mass, and of Definite Proportions.

3. *How one may distinguish between the simple types of chemical change:* union, decomposition, and displacement.

4. *How molecules are related to chemical change.* Atomic and molecular structure. Significance.

Unit II. The Nature of Solutions

1. *How true solutions differ from true suspensions.* As to settling out, diffusion, changes in boiling and freezing points, osmosis, filtration, saturation phenomena. Practical applications.

2. *The intermediate nature of colloidal conditions.* Comparisons on the basis of the six above phenomena. Brownian movement. Color changes. Sols and gels. Protective colloidal action. Dimensional relationships between solutes, colloids, and true suspensions.

3. *How dissolved substances are recovered from solution.* Precipitation method and the softening of water. Distillation and fractional distillation. Evaporation and formation of crystals. Crystalloid *vs.* colloid. Relative solubility and formation of crystals. Hydrated crystals. Efflorescence and deliquescence. Fractional crystallization.

4. *Characteristics of solutions having solvents other than water.*

Unit III. What the Chemical Formula Represents

1. *Qualitative representation of structure in the symbols of chemistry.* Dalton's assumptions. Qualitative meaning of symbols in formulas. Derivation of symbols.

2. *Quantitative representation of structure in the symbols of chemistry.* Molecular and atomic weights. Relative weights of molecules and atoms. Computations from the formula. The G. M. V. and Avogadro's hypothesis. Changes in boiling point and freezing point in relation to molecular weights. Reason for this relationship. Volu-

metric and gravimetric relationships and Gay-Lussac's law. Exponents and coefficients. Radicals. Representation of water of crystallization. Problems. Percentage composition from the formula.

3. *How formulas are derived from experimental data.* From percentage composition, or from experimental weights. Find fractional part of each atomic weight represented and express in the small-whole-number relationship. Verify the formula by comparison with the experimental molecular weight. Elements in the free condition.

4. *How the simplest formula is derived from the name of the substance.* Multiple proportions and valence. Positive and negative elements and radicals. The use of valence in formula writing.

Unit IV. How Chemical Changes Are Represented

1. *Equations and chemical change.* Meaning of pluses and arrows. Relation between word-equations and formula-equations.

2. *How the equation represents weight relationships.* The balancing of equations. Conservation of mass and definite proportions. Equivalent weights and reacting weights. Problems dealing with equations. Molecular and atomic weights as relative rather than absolute weights.

3. *How the equation represents volume relationships.* Representative of gaseous conditions only. Relationship between coefficients and G. M. V.'s represented. Problems dealing with equations.

Unit V. Ionization and Ionic Reactions

1. *Dissociation in solution.* Differences between the solutions of ionogens (ion formers) and of non-ionic substances. Characteristic reactions of the ionogens (acids, bases, salts). Relationship between dissociation and carrying capacity for electricity; between dissociation and degree of acidity or alkalinity; between dissociation and abnormality of changes in b. p. and f. p.; between dissociation and the degree of concentration of the solution.

2. *Characteristic reactions among ionogens.* Why characteristic only when in water solution. Chemical equilibrium in solutions. The dynamic quality of chemical equilibrium. Conditions which will prevent equilibrium and cause reactions to go to completion. Double decomposition as a type of chemical change. Why neutralizations go to completion.

Unit VI. The Metallic and Non-Metallic Nature of the Elements

1. *Characteristics of the metallic elements.* (Consider iron, copper, lead, gold, calcium, platinum, silver, potassium, sodium, cadmium, and magnesium as representative.)

Physical properties; luster, sp. gr., malleability, ductility, tenacity, hardness, m. p. and b. p., formation of alloys, conductivity. Chemical properties; formation of positive ions in solution; formation of basic oxides; the displacement series, with applications.

2. *Characteristics of the non-metallic elements.* (Consider carbon, sulfur, oxygen, nitrogen, phosphorus, and the halogens as representative.)

Physical properties; make numerical comparisons with the metallic group on the basis of the nine physical properties cited. Chemical properties; formation of negative ions in solution; formation of acidic oxides; displacement series with applications and relationship to atomic weights.

3. *Characteristics of the intermediate groups.* (Consider arsenic, antimony, zinc, aluminum, chromium, and manganese as representative.)

Physical properties; compare with metals and non-metals. Chemical properties; either basic or acidic reactions of oxides, depending on the other reagent. Types of compounds formed by these elements. The gradual gradation from the most metallic to the most non-metallic characteristics among the various elements.

Unit VII. The Nature of Chemical Action Involving Oxidation and Reduction

1. *Simple oxidations brought about by atmospheric oxygen.* Burning of fuels; rusting of metals; oxidation and combustion; three factors necessary for burning; conditions necessary for putting out fire; kindling temperature and spontaneous combustion.

2. *Simple reduction processes brought about by carbon.* Reduction on the charcoal stick; heating in closed containers in presence of carbon; reduction of metallic ores by the use of coke or coal; practical applications in metallurgy; roasting compared with reduction; iron smelting; hydrogen as a reducing agent.

3. *Oxidation and reduction as reactions which primarily involve changes in valence.* Other oxidation and reduction reactions than those involving carbon and oxygen. Reducing and oxidizing agents; what happens to them in reactions. Practice in recognition of oxidation and reduction reactions.

4. *The characteristic reactions of common oxidizing agents.* Sulfuric and nitric acids as oxidizing agents; potassium chlorate, permanganate, and dichromate; aqua regia; bleaching powder; chlorine; hydrogen peroxide; manganese dioxide.

5. *Other effects of oxidation and reduction processes.* Bleaching; killing bacteria; removing ink stains; etc.

Of the three remaining units, one will deal with the "Periodic Classification of the Elements," another with "The Influence of Modern Chemical Knowledge in the Development of Industry and Medicine," and the third with some phases of organic chemistry. The less able student may be able to complete only eight units, while the best ones may need an extra one. The analysis of simple unknowns by blow-pipe and closed tube methods would be suitable for special work for this latter type of student.

As a final word, it may be well to call attention to a feature in the unit organization of a course that is too often overlooked. In order to be really teachable, in that it is possible by means of the unit to lead the student to the place that he can predict behavior, the unit must be explanatory and not purely descriptive. "Copper and Its Properties" is not a satisfactory title, since it is necessary only to present a series of facts in order to satisfy the title. There is no necessity for tying these facts together by means of a unifying principle. No dynamic relationship is involved. The cause and effect relationship must be the basis for unification, since prediction of behavior is thereby made possible. "How" questions are the ones around which the course must be organized; "what" questions are valuable only as a means to the end. To give the proper starting point for organizing a unit, the title, "Water," would be entirely inadequate. "How Water Acts as a Solvent," would be a very decided improvement. The former leads to description only; the latter requires explanation.

ASSOCIATION AND POLYMERIZATION

S. T. Bowden, University College of South Wales and Monmouthshire, Cardiff, Wales

As a result of recent work on the molecular complexity of liquids and gases the phenomena of association and polymerization have obtained an added importance and significance. However, a considerable diversity of opinion is evidenced in the literature and standard works of chemistry as to the precise method of specifying the various types of combination which obtain between molecules of the same kind. It is the purpose of the present paper to discuss briefly the chemical combination of like molecules with a view to a more precise classification of the fundamental features.

According to Mellor[1] the doubling or trebling of molecules as a result of chemical combination is called polymerization, and polymerism is the term applied to the special case of isomerism when the percentage composition of two or more substances is the same, but the molecular weight is different. Nernst[2] employs the expression polymerization of liquids and reserves the term association to specify the combination of a solute ion with a neutral molecule of solvent. Many authors,[3] however, use the terms synonymously, but Alexander Smith[4] refers to mixtures of gaseous molecules which are multiples of the simplest possible as associated vapors, and liquids composed of more complex aggregates than the simplest possible as associated liquids. Moreover, he points out that in all such cases dissociation into simpler molecules takes place gradually as the temperature is raised. On the contrary, when a substance changes sharply into another substance, as formaldehyde into para-formaldehyde, the phenomenon is called polymerization.

Although the terms polymerization and association are frequently applied to the formation of more complex aggregates of elements, it will be convenient to confine the present discussion to the consideration of the molecular complexity of compounds as distinct from that of the elements.

The combination between like molecules may be broadly divided into two classes: (*a*) the combination between "odd" molecules, *i. e.*, molecules of odd molecular number, indicating a free bond or free valence electron, and (*b*) the combination between molecules of even molecular number.

In class (*a*) reversibility is the salient feature, an equilibrium being produced depending on the temperature, pressure, and the nature of the solvent. This class comprises the so-called "free radicals"; the triarylmethyls of Gomberg, the divalent nitrogen compounds of Wieland, the metal ketyls

[1] "Modern Inorganic Chemistry," Longmans, Green and Co., **1919,** p. 549; "Treatise on Inorganic and Theoretical Chemistry," Longmans, Green and Co., **1927,** Vol. I, p. 856; Vol. V, p. 722.

[2] "Theoretical Chemistry," Macmillan and Co., **1923.**

[3] Chadwell, *Chem. Reviews,* **4,** 375 (1927).

[4] "Introduction to Inorganic Chemistry," The Century Co., **1923,** p. 282.

of Schlenk, and the simple inorganic odd molecules like chlorine peroxide and nitrogen peroxide. This type of combination is to be regarded as association, and results in the formation of a potentially non-polar, covalent linkage. The reversal of the process involves the generation of a free valence and is thus correctly designated molecular dissociation.

On the other hand, in class (*b*) the combination occurs between molecules of even molecular number and two fundamentally different types of union may be recognized: (1) *irreversible combination*, as for example the union of three molecules of acetylene to give benzene, or the formation of para-formaldehyde from three molecules of formaldehyde, and (2) *reversible combination*, as occurs in the case of $(H_2O)_n$ in the liquid state, or $(AlCl_3)_2$ in the gaseous state. In the latter case an equilibrium is set up between molecular complexes of even molecular number, whereas in the free radical systems the equilibrium obtains between odd and even numbered molecular entities.

If we examine the three above-mentioned types of union in the light of the modern conception of valence, it will be evident that the chemical character of the combination is different in each case, as indicated in the following scheme:

	Example	Type of linkage	
1. Odd Molecule Combination	$2Ph_3C \rightleftharpoons Ph_3C.CPh_3$	Normal covalent	Association
2. Even Molecule Combination (*Irreversible*)	$3C_2H_2 \rightarrow C_6H_6$	Normal covalent	Polymerization
3. Even Molecule Combination (*Reversible*)	$2H_2O \rightleftharpoons (H_2O)_2$	Semi-polar or coördinate	Semi-polar association

On the premises of this classification, the first type of combination is termed association, the second type polymerization, while the third type may be conveniently designated *semi-polar association*. In the third type of union, one of the atoms of the molecule functions as *donor* and another as *acceptor* atom.[5,6] The term semi-polar association gives expression to the fact that the combination of the like molecules occurs through the formation of the coördinate or semi-polar link.

[5] Sidgwick, "The Electronic Theory of Valency," Oxford University Press, **1927**, p. 52.

[6] Sugden, "The Parachor and Valency," Routledge and Sons, Ltd., **1930**, p. 114.

Limestone Reduces Friction in Street Car Bearings. Just as crushed rock is mixed into concrete, so small pieces of limestone are added to molten bearing metal to form a conglomerate which is in successful use on tramcars in Germany. The theory of this revolutionary procedure is that the limestone acts as a sponge and absorbs the oil.—*Science Service*

SELLING HIGH-SCHOOL CHEMISTRY TO THE COMMUNITY

R. C. KISTLER, BLOOMSBURG HIGH SCHOOL, BLOOMSBURG, PENNSYLVANIA

The plan set forth in this article has been adopted by three schools (I will call them *A*, *B*, and *C* for convenience)—in central Pennsylvania, each being within a radius of twenty miles of the other, and each having a combined enrolment of approximately 10,000. The objectives of the plan are: (*a*) to "sell" chemistry to the community; (*b*) to arouse student interest in chemistry.

The plan itself hinges on the idea of an inter-school contest; however, instead of using athletic teams, chemistry teams are used. Each school has one team, composed of five members, including the captain, for each competitive unit, of which there are four, namely: (1) essays, (2) notebooks, (3) equation and formula writing, (4) displays of products and processes.

The personnel of each respective team is composed of those whose work is of such a caliber in that particular unit that they are selected by the teacher to be used in the contest. The mode of selecting will vary with the teacher. The teacher, however, must be very careful that he does not train special students for certain teams; he must select the best from a trained group. In addition to "varsity," "junior varsity" and "scrub" teams may be selected.

In an athletic contest there must be a time, place, judge, and sometimes awards, such as cups, trophies, medals, ribbons, etc. The chemistry contest requires similar arrangements.

There are three contests, one being held in each of the towns participating; hence the different communities help each other to attain their objectives. Each contest is usually held within a period of one week—preferably, some week in May. It is only on the first night that the following awards are presented by the judges who have previously judged the competitive units, submitted by the three schools and designated first, second, third, fourth, and fifth places in each unit—

(1) **Medals**—To the individuals who are winners of first places.
(2) **Blue Ribbons**—To the individuals who are winners of second places.
(3) **Red Ribbons**—To the individuals who are winners of third places.
(4) **Honorable Mention**—To the individuals who are winners of fourth and fifth places.
(5) **Large Cup**—To the school having the greatest total of points (points received for places).
(6) **Small Cup**—To the school submitting the three best essays.

With such an aggregate of awards, motivation and competition run very high. It is understood that the essays should be in the hands of the judges at least two weeks prior to the date of the first contest, and that displays and notebooks of each school must be at the place of contest not later than the day of the evening of contest. Plenty of time must be

given the judges. In the second and third contests, which are held in the two other schools on other nights, different judges are used and awards are in the form of honorable mentions. It is a desirable factor to use the "junior varsity" and "scrub" teams on these nights.

The following shows how the plan is carried out by school *A* in preparation for the contest to be held at its school. Previous to this date, students of the chemistry classes in school *A* plan their advertising for its "Chemistry Carnival" (any name as "Science Meet," "Chemistry Meet," etc., can be used). Chemistry slogans, such as "Chemistry gives us pure water," "Chemistry increases our span of life," "Chemistry made Ford millions," etc., are printed on placards, and posted throughout school and town. Invitations written in the English classes are sent to the students' parents.

Press announcements are made; assembly features, relating to the "Chemistry Carnival," are presented to the students. By the date of the contest, much enthusiasum and interest have been aroused.

On the night of the contest the patrons are ushered into the auditorium, thence to the section designated for them, where they receive from the usher a unique science program—made entirely by the students—relating the events of the evening. Students of the different schools find places in the respective student sections, where, with their cheer leaders, they cheer their teams. Selections from the school band or orchestra help greatly to keep up the interest.

This program should take about forty-five minutes. It usually consists of the following numbers—short talks, science sketches and playlets, dance and song numbers, formula and equation writing, and announcements of winners and awards given by the judges. At this time we should explain how the formula and equation writing teams compete, because this number contains the spice of the program. Each team, as we know, has five members; one member of each of the three teams compete against each other on the stage at one time. At first the curtain is called, then in back of the curtain on the stage are placed three revolving blackboards on a line parallel to the curtain. On each blackboard, names of twenty-five chemical substances are written on one side, and ten incomplete equations on the other. In front of the curtain, each of the three contestants, facing the audience, are placed on a line perpendicular to the blackboard upon which he is to work. The curtain is drawn and the signal is given to begin. The contestant turns around and begins to write the formulas for the chemical substances. When a contestant has completed the formulas, the judge, who stands near by, signals for the blackboard to be turned, and the contestant completes the equations.

The contestant finishing first holds up his hand; then the judge gives the signal for the two other contestants to stop. The results are then

corrected and points awarded. After the four other contests in "equations and formula writing" have been staged, every one feels he has had a delightful and hilarious evening.

After the program in the auditorium is finished, the patrons and students are shown through the laboratories, where the notebooks, essays, and displays that were entered in competition by the different schools are on exhibition; as well as notebooks, essays, displays, drawings, etc., of all the students of the home school. The latter include some work of other science classes as well as chemistry. Students are stationed by the displays and models to explain the different processes; students are also working at the laboratory desks, doing some experiment that has a great community value.

The system of scoring in determining the winner of the cup is very indefinite. It depends on teachers and schools, as does the entire plan above; it must be changed to fit the school and locality. The usual method is, first place, five points; second place, three points; third place, one point; fourth and fifth places, one-half point.

Following are the criteria by which the units are judged: *notebook*—neatness, originality, order and utility; *displays*—utility, time to prepare, chemistry involved, practicability and appearance. *Essays*—follow the rules of American Chemical Society. *Equation and formula writing*—see above.

In conclusion we should add that full houses were present on each night of the competition; annual awards, for best displays, were offered to students by towns-people, but more important is the fact that the pupils of the competing schools are actively engaged in a work that brings the interests and the thinking of the school and community closer together.

Research Turns from Paints to Study the Woods Painted. Not only the paint but also the surface have been receiving recently the attention of scientists. What qualities of wood make it almost impossible for paint to stick is revealed by Dr. F. L. Browne, senior chemist of the U. S. Forestry Products Laboratory at Madison, Wis., in a recent report to the Engineering Foundation.

"Paint fails by flaking from the summerwood, the dense, horny, dark-colored part of the annual growth ring," Dr. Browne says. "As failure progresses the summerwood may be left bare while the springwood is completely covered."

Light-weight wood of even texture has thin bands of summerwood and holds paint well, he points out. But most heavy wood is uneven with wide bands of summerwood and therefore sloughs paint off rapidly. Edge-grain boards expose summerwood in narrower bands and hold coatings better than flat-grain boards from the same log.

Little can be done, however, to change the type of woods in use, Dr. Browne acknowledges. He urges further research with paints. Aluminum paint as a primer under customary house paints on summerwoods has been found greatly to lengthen the life of the coating.—*Science Service*

THE ORGANIZATION OF THE HIGH-SCHOOL SCIENCE CLUB

RALPH E. DUNBAR AND CARRIE SCHAFER, DAKOTA WESLEYAN UNIVERSITY, MITCHELL, SOUTH DAKOTA

This material is designed primarily for high schools with an enrolment of 75 to 400 students. In schools of this size it does not seem advisable to attempt a strictly "chemical" club. The club should be organized to include all students interested in science and it should have the coöperation of all the science departments. The suggested outline may be helpful to those organizing such a science club for the first time. Students should be encouraged to take the initiative and to formulate the necessary plans to meet the needs of their particular school.

Organizing the Club

1. Call a meeting of all students interested in a science club.
2. Explain the purpose and organization of such a club.
3. Select a committee to formulate a constitution.
4. Elect officers.
5. Adopt a constitution and give each member a copy of it.
6. Adopt a name for your club that will suggest its special interests.
7. Make the club worthwhile and membership an honor and privilege.
8. Hold initiation ceremonies.
9. Make it a *real club*. (Students of high-school age thrive on clubs.)
10. Adopt a badge or button for the club.
11. A motto always helps.

Suggested Constitution

ARTICLE I. *Purpose.*

The purpose of this club shall be to increase the knowledge of and interest in science.

ARTICLE II. *Name.*

The name of this club shall be The Benzene Ring of Blank High School.

ARTICLE III. *Membership.*

SEC. 1. Membership is open to any one interested in science.

SEC. 2. All members must make at least one contribution per month to the programs.

ARTICLE IV. *Meetings.*

SEC. 1. Meetings shall be held every Wednesday evening at 7.30 P.M. in the science lecture room.

SEC. 2. Special meetings may be called by the president at any time.

ARTICLE V. *Money.*

SEC. 1. Dues shall be twenty-five cents per quarter, payable in advance.

SEC. 2. The money shall be used to furnish necessary apparatus and materials for programs, including slides, movies, eats, etc.

SEC. 3. Special assessments may be made if voted by (2/3) two-thirds of the enrolled membership.

ARTICLE VI. *Expulsions.*

SEC. 1. Any member who fails to pay his dues within one month is automatically suspended.

SEC. 2. A suspended member may be reinstated by the payment of all past dues.

SEC. 3. A member may be suspended for four consecutive absences from meetings or for failure to contribute his share to the programs.

ARTICLE VII. *Programs.*

SEC. 1. The business program of regular meetings shall never last longer than fifteen minutes.

SEC. 2. The science program shall never last longer than one hour.

SEC. 3. The science programs shall be planned by the president and vice-president with the aid of the professor in charge.

ARTICLE VIII. *Officers.*

SEC. 1. The officers of this science club shall be: *President, Vice-President, Secretary, Treasurer, Sergeant-at-Arms,* and *Scouts.*

SEC. 2. Their duties shall be those usually connected with such offices and, in addition, the following: The Vice-President shall take charge of the programs. The Scouts shall investigate places where excursions for the club may be arranged. The Sergeant-at-Arms shall be custodian of apparatus and shall act as assistant to lecturers and demonstrators.

SEC. 3. Elections shall be held at the beginning of each school year.

SEC. 4. Officers may resign and may be impeached.

SEC. 5. A two-thirds vote shall be needed for impeachment.

SEC. 6. Special elections may be held whenever an office is declared vacant.

ARTICLE IX. *Amendments.*

This constitution may be amended by a two-thirds vote.

Outline for Program of Regular Club Meetings

1. Roll Call.
2. Reading of Minutes.
3. Business.
4. Science Program.
   (*a*) Current Events in Science.
   (*b*) Demonstrations.
   (*c*) Lecture.
   (*d*) Questions and Contributions.

Program Suggestions

The aim of the club, its special interests, the community, and many other factors will influence the club programs. Once interest is started, more new ideas will be suggested than the average program committee will be able to work out.

1. Stereoptican and motion picture shows on science topics.
2. Stunts with a purpose.
3. Trips to local industrial plants: power plant, flour mill, bakery, creamery, telephone exchange, telegraph office, machine shop, saw mill, packing plant, greenhouse, etc.
4. Science plays.
5. Talks by outside speakers.

6. Chemistry party: guessing games, contests, and experiments. Use beakers for glasses, spatulas for knives, watch glasses for plates, etc.
7. Physics department program.
8. Bird study.
9. Astronomy.
10. Fire prevention: extinguishers, talk by local fire chief, report on local fire hazards.
11. Photography: how the kodak is made, taking pictures, developing and printing.
12. Soap sculpture.
13. Magic.
14. Biology program.
15. Armistice day program: science in war, science in peace.
16. Open meeting: invite guests.
17. Debates.
18. Biographies of famous scientists.
19. Glassblowing.
20. Science exhibit.
21. Other activities.
    (*a*) Hold a carnival.
    (*b*) Develop a science column in the school paper.
    (*c*) Make science scrapbooks.
    (*d*) Write essays for the American Chemical Society National Prize Essay Contest.
    (*e*) Investigate local problems such as milk supply, water supply, sewage disposal, control of disease.
    (*f*) Present a science program in the general assembly.
    (*g*) Science posters.

Insignia and Badges

Pins and badges for science clubs may be obtained for twenty-five cents and up, from the following:

1. *The Science Classroom*, 381 Fourth Ave., New York, N. Y.
2. "Ace" Badge, Button and Medal Co., 303 Fifth Ave., New York, N. Y.
3. Dieges & Clust, 15 John St., New York, N. Y.
4. Eagle Regalia Co., 115 Nassau St., New York, N. Y.

Bibliography of Science Club Helps

Ideas for programs, experiments, demonstrations, and activities may be found in the following:

Organization of Clubs

THIS JOURNAL

ASTELL, L. A., "Fostering Science Clubs in the High School," **6**, 496 (1929).

THIS JOURNAL

MCGILL, MARTIN V., "A Live Chemistry Club in High School," **1,** 31 (1924).

WALKER, HAROLD, "The High-School Chemistry Club," **3,** 462 (1926).

WALTERS, ORVILLE, "A Successful Chemistry Club Initiation," **6,** 958 (1929).

General Science Quarterly

MEISTER, MORRIS, "Managing a Science Club," **7,** 1 (1922). Same as *Sch. Sci. Math.* reference below.

School Science and Mathematics

ASTELL, LOUIS A., "Initiation Ceremony of the Edisonian Science Club," **28,** 771 (1928).

CHUTE, W. N., "The High-School Botanical Club," **22,** 147 (1922).

LUSSENHOP, RAYMOND, "The Organization of a Science Club," **7,** 461 (1907).

MEISTER, MORRIS, "Managing a Science Club," **23,** 205 (1923). Same as *Gen. Sci. Quart.* reference above.

Program Suggestions

THIS JOURNAL

A. C. S. INSTITUTE, "Motion Pictures for Science Classes," **5,** 1294 (1928).

ANONYMOUS, "Odd Experiments," **5,** 1333 (1928).

ANONYMOUS, "Open Meeting of the Chemistry Club of Lorain High School," **2,** 294 (1925).

BAKER, R. A., "Museum Reactions," **2,** 480 (1925).

BATEMAN, A., "Chemistry Saves the Day," **7,** 164–6 (Jan., 1930).

BERGEN, R. C., "Chemistry on the High-School Stage," **6,** 963 (1929).

BILLINGER, R. D., "Illustrating the Black Art," **3,** 897 (1926); "A Night in Alchemy," **5,** 715 (1926).

COPE, H. F., "Chemistry Club Work," **7,** 1115–7 (May, 1930).

FARSON, M. ELIZABETH, "The Cinderella of the Metals," **2,** 57 (1925).

HALL, ALTON L., "The New Assistant," **2,** 600 (1925).

HEINTZ, W. W., "A Janitor's Life," **6,** 1793 (1929).

JACOBS, ADELINE H., "Friendly Fire," **6,** 1787 (1929).

JORDY, LOUIS C., "Explosives; A Burlesque Lecture," **7,** 653 (1930).

LAMAR, WILLIAM L., "Fraternity Initiation—A One-Act Burlesque," **6,** 2254 (1929); "The Arabian Barber Shop," **6,** 2011 (1929).

RUDDICK, DOROTHY, ELIZABETH WINGER, AND MARCIA CAHALAN, "Interference—A Chemical Play," **4,** 905 (1927).

WALTERS, ORVILLE, "Industrial Motion Pictures in the Classroom," **6,** 1736 (1929).

General Science Quarterly

NORMAL COLLEGE STUDENTS, TRURO, N. S., "An Ounce of Prevention," **8,** 373 (1923).

UNDERHILL, O. E., "The Captain's Compass," **9,** 173 (1925).

School Science and Mathematics

HART, FRED T., "Suggestions for Fire Prevention as a Program for General Science Classes," **25,** 153 (1925).

OTTO, CARL, AND FRIEDMAN, HAROLD B., "A Chemical Vaudeville Show," **28,** 755 (1928).

Science

JACOBSON, C. A., "A Chemical Spelling Match," **56,** 368 (1922).

Science Education

MILLER, DONALD W., "Suggested Programs for a Science Club," **14,** 331 (1929)

Miscellaneous

BENEDICT, F. G., "Chemical Lecture Experiments," The Macmillan Company, New York City, **1901.**

DAVISON, H. F., "A Collection of Chemical Lecture Experiments," The Chemical Catalog Co., Inc., New York City, **1926.**

NEWTH, G. S., "Chemical Lecture Experiments," Longmans, Green and Company, New York City, **1910.**

NATIONAL BOARD OF FIRE UNDERWRITERS, "The Trial of Fire," 76 Williams St., New York City.

UNIVERSITY APPARATUS COMPANY, "The Plant Wizard," 2229 Nugee Ave., Berkeley, California.

Special Activities

THIS JOURNAL

BAWDEN, ARTHUR T., "A Chemical Party," **4,** 86 (1927).

BELL, FANNIE L., "A Chemistry Exhibit," **5,** 280 (1928); "Posters in Chemistry," **5,** 157 (1928).

BREWINGTON, G. P., "Lead Trees Grown in Gels," **6,** 2228–30 (Dec., 1929).

DUNBAR, RALPH E., "The Chemistry Open House as an Aid in Instruction," **5,** 531 (1928).

ELKING, ESTHER, "The Game of Chemists," **7,** 636 (1930).

JACOBS, A. H., "Chemical Posters," **2,** 792 (1925).

KISTLER, R. C., "Selling High-School Chemistry to the Community," **7,** 1324–6 (June, 1930).

LAW, S. D., "High-School Projects in Chemistry," **6,** 1139 (1929).

PRICHARD, D. W., "The Water Supply," **5,** 1671 (Dec., 1928).

PRUITT, CLARENCE M., "Activities of Chemistry Clubs," **4,** 1037 (1927).

RAKESTRAW, NORRIS W., "A Model Chemistry Clubroom," **7,** 891 (1930).

SPIERS, C. H., "A Chemical Museum Exhibit," **6,** 730 (1929).

STONE, CHARLES H., "Posters in High-School Chemistry," **6,** 1535 (1929).; "Lead Tree (Arbor Saturnii)," **6,** 355–6 (Feb., 1929).

School Science and Mathematics

FELDMAN, L. C., "Outside of Classroom Activities in Science," **20,** 700 (1920).

HERRIOTT, M. E., "Assembly Programs from Class Work," **25,** 150 (1925).

Metallized Bank Notes. Just twenty years ago M. C. Schoop, of Zurich, began the development of a process for metallizing wood, paper, and other materials, in which the surfaces are metallized by spattering with droplets of molten metal. The improvements of subsequent years included means for melting the metal in an electric arc or in an oxy-hydrogen burner of special construction, with atomizing nozzles of different types and mechanical devices to regulate the thickness of deposits by controlling the rate of feed. The metals that lend themselves to the production of extremely thin films by this process are especially copper, zinc, tin, lead, and aluminum.

A year ago announcements were made of a method of metallizing paper with zinc or copper, in which the essential feature was a device for regulating the rate of movement of a sheet of paper below an atomizing nozzle, to correspond with the rate at which the metal was atomized. At present the method has attained a degree of success that leads the inventor to hope for the production of bank notes, coated with tin or copper, which may readily be folded or crumpled, but which will be impossible to ignite, very difficult to tear, and of extraordinary wearing quality. The metallized paper has some applications in prospect in telephone and radio technic.—*Ind. Bull., A. D. Little, Inc.*

A METHOD OF TEACHING EQUATION WRITING

CHARLES H. STONE, ENGLISH HIGH SCHOOL, BOSTON, MASSACHUSETTS

The importance of the equation in any course in chemistry is obvious. The ability to write chemical equations correctly is of the first importance, but is often acquired by the beginner only with difficulty and after continued practice. Too often the method of presentation is uninteresting and dry and the student comes to regard equations as a necessary evil and a bugbear. But the subject can be presented in such a way as to become interesting instead of unattractive to the student. The writer has used the method described below for a number of years with good results. Previous work on valence and formula writing has, of course, been taken up.

Arrange upon the lecture desk a dozen or more 50-cc. graduates and fill each about half full of water. Behind each graduate place two bottles containing solutions of reagents which, when mixed, will produce a precipitate. For example, the first pair of bottles might contain silver nitrate and hydrochloric acid. The bottles should be arranged in such order that the successive equations will increase in difficulty but not too rapidly. The following pairs of reagents may be used:

Mercurous nitrate and potassium iodide	Barium chloride and zinc sulfate
Silver nitrate and sodium chloride	Lead nitrate and potassium iodide
Silver nitrate and potassium iodide	Mercuric chloride and potassium iodide
Copper sulfate and sodium carbonate	Lead nitrate and potassium chromate

Many other pairs will suggest themselves to the interested teacher. Such difficult combinations as ferric chloride and potassium ferrocyanide or aluminum sulfate and barium chloride should be deferred until the students have acquired a considerable mastery of the simpler equations.

When all is ready, the teacher may explain briefly the method of procedure and then call Johnny down to the desk to perform the first experiment. He pours together into the first graduate silver nitrate and potassium chromate, let us say. A red precipitate is formed. He is then asked to write the equation on the blackboard, the teacher making needful suggestions at first. Then comes up the question of color. From the equation it is apparent that two products are formed, silver chromate and potassium nitrate. Which one of these is the red one? At this point the teacher may put forward a bottle containing solid potassium nitrate and ask the class to note the color of it and then to draw their conclusions. At once they will arrive at the conclusion that the red precipitate must be silver chromate. The color is then indicated on the board by writing the word "red" above or after the formula for the silver chromate. Johnny then sits down and Jennie is called to the desk and the process repeated with the next pair of solutions. Since a little skill in arranging the pairs of bottles will prevent the continued recurrence of the same color, an expectant attitude regarding the next color develops in the class.

With the more difficult equations, such as the reactions between the chlorides of arsenic and antimony with hydrogen sulfide, the question of coefficients will of course come up. A spirited class discussion may be started and the question threshed out to the satisfaction of the students.

Some surprising things may be introduced to heighten the interest. For example, the reaction between a little lead nitrate and hydrogen sulfide produces a black precipitate. Addition of hydrogen peroxide will change this to white lead sulfate by oxidation. The precipitate formed by potassium iodide and mercuric chloride will disappear if more potassium iodide is added, as will, also, the white precipitate formed by the action of sodium hydroxide on soluble lead salts when more sodium hydroxide is added, the plumbite being formed.

This series of experiments can be continued through several recitations at the teacher's option, gradually leading up to the more difficult equations for reactions in solution. The class exercises should be supplemented by similar exercises in the laboratory. It is not unusual to hear students in the laboratory remark: "Gee! This is the most interesting experiment yet!"

Cadmium Oleate as an Impregnating Material. Dr. H. J. BRAUN describes (*Chem.-Ztg.*, Nov. 29, **1929**) the use of cadmium oleate as an impregnating material. Cadmium hydroxide after treatment with olein and dehydration gives a brown product which is soluble in many organic solvents, especially benzene, toluene, xylol, and amyl acetate, yielding, at suitable concentrations, almost colorless jellies. Colloidally dispersed in ammonia, in which it gives stable dispersions, it forms an excellent impregnating material. Tiles, as well as linen of suitable mesh, become impervious to water after impregnation and drying at the ordinary temperature. Filter paper or ordinary blotting paper shaped into bags can be used to carry water. Tests of the durability of the impregnating material are, as yet, incomplete, but tiles and pieces of unglazed clay have remained unchanged for years after impregnation. Results with cellulose lacquers, however, are less satisfactory. Other cadmium compounds of the fatty acids such as the palmitate and the stearate show similar but graduated properties.—*Chem. & Ind.*

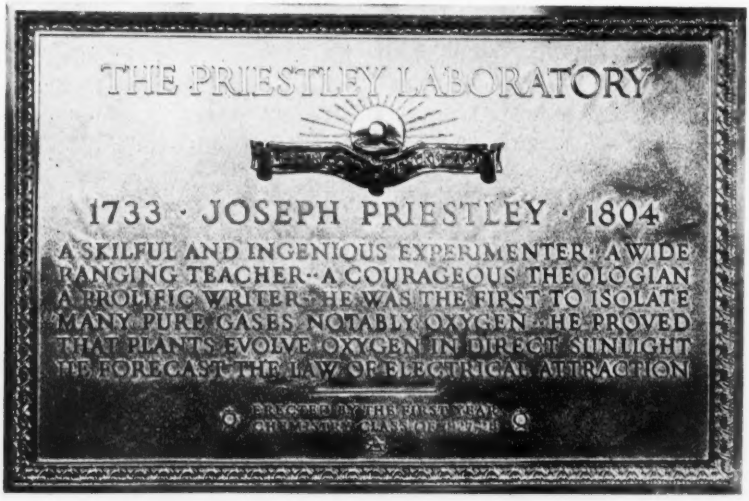
Richard Chenevix. There were two Richard Chenevix, if the plural of the proper noun is thus correctly rendered; we are concerned with the chemist and mineralogist, son of the bishop's nephew. Born in 1774, probably in Dublin, he began in 1800 to publish scientific communications in *Nicholson's Journal*, and in 1801 in the *Philosophical Transactions of the Royal Society*, of which society he was in the same year elected a Fellow. He examined Hatchett's newly discovered "columbian," he investigated the magnetic properties of nickel, and made a special study of palladium and platinum. The former precious metal was regarded by him as an alloy of platinum with mercury, but it was subsequently classed as a new metal by Wollaston, who had also discovered platinum. Chenevix' contributions to chemical science were by no means insignificant, nor were they unrecognized, for in 1803 he was awarded, for his various researches, the Copley gold medal of the Royal Society. It may be remembered that in February of last year we referred to the centenary of the death of Wollaston, Chenevix' successful rival, and indulged in some thoughts concerning the survivor. Time passes, and it is the survivor's death, on April 5, 1930, that we now recall.—*Chem. & Ind.*

MEMORIALS IN CHEMISTRY LABORATORIES. II. PRIESTLEY

JESSE E. DAY, THE OHIO STATE UNIVERSITY, COLUMBUS, OHIO

On the occasion of the Seventy-eighth Meeting of the American Chemical Society[1] one of the seven general chemistry laboratories in the new Chemistry Building of The Ohio State University was dedicated to the memory of Edward Williams Morley and named the Morley Laboratory. An appropriate bronze tablet,[2] presented to the Department of Chemistry by Mr. John Brush Hatcher representing the first-year chemistry class of 1926–27, had previously been placed in position on one of the walls of this room.

On the same occasion a plaque similarly honoring Joseph Priestley[3] was


THE PRIESTLEY LABORATORY
1733 · JOSEPH PRIESTLEY · 1804
A SKILFUL AND INGENIOUS EXPERIMENTER · A WIDE RANGING TEACHER · A COURAGEOUS THEOLOGIAN
A PROLIFIC WRITER · HE WAS THE FIRST TO ISOLATE MANY PURE GASES NOTABLY OXYGEN · HE PROVED THAT PLANTS EVOLVE OXYGEN IN DIRECT SUNLIGHT
HE FORECAST THE LAW OF ELECTRICAL ATTRACTION

unveiled by Misses Phoebe Arnold Paine and Bertha Sarah Roberts and presented to the Department as from the first-year chemistry class of 1927–28. Later this tablet was mounted in a second of the laboratories devoted to instruction in first-year chemistry, and the laboratory designated as the Priestley Laboratory.

The ceremonies were brought to a close following the presentation to Dean William McPherson (representing the president of the university, George W. Rightmire) by Mr. Edwin Wilmot Earhart of a check for a subscription from the first-year chemistry class of 1928–29—this "to be

[1] Division of Chemical Education, April 30, 1929.

[2] Evans and Day, THIS JOURNAL, **6**, 332–3 (Feb., 1929).

[3] This tablet was designed by Thomas Ewing French, Professor of Engineering Drawing, The Ohio State University.

used for the design and purchase of a tablet in honor and memory of Antoine Laurent Lavoisier and the erection of same in one of the remaining general chemistry laboratories."

This meeting of the American Chemical Society marked the completion of the construction of a new million dollar chemical hall at this University. It was truly an occasion for rejoicing, particularly on the part of those whose lives, for many years, have been devoted to instruction in the departments housed in this structure.

No one familiar with the science of chemistry is unmindful of the fact that a chemistry hall is essentially a workshop or laboratory. Chemical workshops for the pursuit of knowledge, perhaps, can never be highly ornate places. To some, chemical laboratories may even seem prosaic in both design and fresco.

For one reason or other we sometimes design laboratories or portions of laboratories so as to embody the architecture of the factory. This one-story unit containing the laboratories of the Division of General Chemistry is of the saw-tooth factory type. All of us feel that an educational institution should have, if possible, buildings which are inspirational in both their exteriors and interiors. When a college building is lacking in this quality, then it becomes imperative that this requirement be met in other ways. Edifices consecrated to the Word have their memorial windows depicting Biblical incidents. At the entrance ways of law buildings we find the masks or faces, carved in stone, of those who were the masters of jurisprudence. What then is more appropriate than the making of an integral part of a chemical laboratory, the spirit of those men or women who have had a profound influence on the science of chemistry? The ever-presence of these spirits should take some material form in order that all who enter these portals may partake thereof. These spirits should so enthuse those who labor within these walls that they, in their turn, may do their full part in pushing back the veil of the unknown.

Find Ozone Useless in Treating Tuberculosis. Low concentrations of ozone are not of much use in treating tuberculosis in guinea pigs, Dr. H. B. McDonnell, of the University of Maryland, has reported to the Association of Official Agricultural chemists. Dr. McDonnell's report was based on results of five years of work.

The pigs were inoculated with tuberculosis and given ozone in concentrations ranging from one part per million to one-tenth part per million. The weaker concentrations had little or no effect on either the pigs or the course of the disease. The stronger concentrations did not ameliorate the disease nor did they prolong the lives of the pigs. In fact the stronger concentrations of ozone seemed to have the opposite effect of shortening the pigs' lives.

Dr. McDonnell said he has not done any work on the effect of ozone on tuberculosis in human beings and has not attempted to apply the results of his work with inoculated guinea pigs to the problem of tuberculosis in man.—*Science Service*

LABORATORY EXPERIMENTS ON THE BOILING-POINT CURVES OF BINARY MIXTURES

FRANK J. SODAY AND GEORGE W. BENNETT, GROVE CITY COLLEGE, GROVE CITY, PENNA.

In a previous paper by one of us[1] laboratory directions were given for plotting the boiling-point curves of non-azeotropic mixtures over the entire boiling-point range. It was pointed out in that place that the usual laboratory experiments on maximum-boiling mixtures give data for the composition of both phases over only a part of the temperature range, and that similar experiments on minimum-boiling mixtures give data for only one phase over the temperature range. It is the purpose of this paper to describe laboratory experiments which give data for the composition of both phases over the entire boiling-point range for each of the three types of binary liquid mixtures.

The difficulty in devising such experiments consists mainly, of course, in utilizing systems that may be analyzed readily. In spite of some 1500 or more azeotropic systems there are only a few that are suited for student work either because they include relatively uncommon laboratory materials or because the systems themselves are unsuitable. Thus, for example, the majority of maximum-boiling systems have as one component either an aqueous solution of a gas, such as the halogen acids, or corrosive and high-boiling substances, such as formic acid, phenols, or cresols. Analysis of many of the minimum-boiling mixtures can be made only by tedious physical methods.

The analysis of some binary liquid mixtures can be effected very rapidly and with a very small sample by the use of the Abbé refractometer. A fair degree of accuracy, moreover, may be had if the refractive indices of the two liquids differ sufficiently. It is desirable also that relatively common materials should be used. With these limitations in mind the following systems were found suitable for laboratory experiments.

A. **Maximum-Boiling Mixtures.**—Chloroform-acetone[2] and chloroform-methyl acetate.[3]

B. **Minimum-Boiling Mixtures.**—Benzene-methanol[4] and carbon tetrachloride-methanol.[5]

C. **Non-Azeotropic Mixtures.**—Benzene-acetone,[6] toluene-acetone,[7] and acetic acid-benzene.[8]

[1] G. W. Bennett, THIS JOURNAL, **6**, 1544 (Sept., 1929).

[2] Lecat, "L'Azeotropisme—La Tension de Vapeur des Melanges de Liquides," Bruxelles, **1918**, p. 178 for data and bibliography.

[3] *Ibid.*, p. 180.

[4] *Ibid.*, p. 99.

[5] *Ibid.*, p. 82.

[6] *Ibid.*, p. 126.

[7] *Ibid.*, p. 126.

[8] *Ibid.*, p. 72.

The materials used were carefully purified. The ordinary laboratory acetone, benzene, toluene, carbon tetrachloride, and chloroform were purified by common methods, and were then dried and fractionated. The other materials were "Eastman" grade. The methanol was acetone-free; the acetic acid was 99.9% pure and melted at 16.6; and the methyl acetate was anhydrous. The values for the boiling points of the materials used, when corrected to 760 mm. pressure, did not vary more than 0.1° from the values listed in the "International Critical Tables," and those for the refractive indices did not vary by more than three in the fourth decimal place from the standard values.[9]

Procedure

The apparatus used for these experiments was the same as that described in the earlier paper, and the procedure also is practically the same. In every case it is desirable to start the distillation with one pure liquid and add successive amounts of the second liquid until the azeotropic point is reached. The contents of the flask are then rejected, and the same procedure is followed beginning with the other pure liquid. An excessive amount of reagent is required if one attempts to trace the curves from the azeotropic point to pure liquid. The amount of pure liquid to add after each sampling varies with the system, but in general if 10 cc. of pure liquid and 15 cc. of distillate are added the change in the boiling point is not too great. In the case of the non-azeotropic systems described in this paper it is usually better to begin with the low-boiling liquid and add the higher boiling liquid although one may follow the opposite procedure. With some non-azeotropic systems, indeed, such as acetic acid-water, it is essential to follow this latter procedure in order to avoid using an excessive amount of acid.

The samples of the liquid and vapor phases are analyzed by means of the Abbé refractometer. The refractive indices of the samples are determined, and the values so obtained are compared to a reference refractive index-composition curve from which the compositions of the samples are found. This reference curve is made by plotting the values for the refractive indices of the two pure liquids against the weight per cent composition. The refractive indices are all determined at 20°C.

Typical Experimental Details

The accompanying graph and Table I give some representative details obtained by the experimental procedure outlined above.

In Table I data obtained in typical distillations are given for each of the three types of distillation mixtures. The first column in each case gives

[9] "International Critical Tables," Vol. III, pp. 215–23; Vol. I, p. 176 et seq.; p. 276 et seq.

TABLE I

Data for the Boiling-Point-Composition Curves

Chloroform-Acetone			Benzene-Methanol			Benzene-Acetone		
Temp. °C.	Chloroform in vapor	Chloroform in liquid	Temp. °C.	Methanol in vapor	Methanol in liquid	Temp. °C.	Acetone in vapor	Acetone in liquid
55.2	0.0%	0.0%	78.6	0.0%	0.0%	79.1	0.0%	0.0%
56.0	9.0	16.0	68.2	8.0	1.0	77.7	4.0	0.9
57.2	18.5	31.0	63.9	15.0	1.5	75.5	10.5	2.5
58.2	27.0	38.0	60.3	24.0	2.0	73.2	15.0	4.2
58.9	35.0	45.0	58.8	28.0	2.0	72.0	21.0	6.5
60.3	47.0	56.0	57.7	30.0	2.5	68.8	35.0	11.0
61.25	58.0	64.0	57.5	30.0	2.7	63.75	49.0	25.0
62.0	65.5	70.5	57.25	32.0	2.7	61.75	58.0	33.5
62.4	76.0	76.0	56.75	33.0	4.0	60.4	65.0	40.5
62.35	81.0	82.0	56.4	38.0	12.0	59.35	70.0	48.0
62.2	87.0	85.0	56.5	37.8	10.0	58.15	76.5	60.0
61.75	91.5	90.0	56.6	38.0	40.0	57.2	83.0	71.0
61.15	94.0	92.5	56.9	45.0	60.0	56.6	90.0	82.0
60.75	96.0	94.5	57.6	50.5	69.8	56.1	94.5	90.0
60.3	97.0	96.0	58.3	58.0	79.0	55.3	100.0	100.0
59.9	100.0	100.0	59.55	69.0	86.8			
			61.9	85.8	95.9			
			63.1	100.0	100.0			
Barometer 732 mm.			Barometer 725.2 mm.			Barometer 732 mm.		

the temperature at which the vapor (column 2) and the liquid (column 3) have the composition in weight per cent of the constituent stated at the head of the column. The barometric pressure in each case is that at which the distillation was performed.

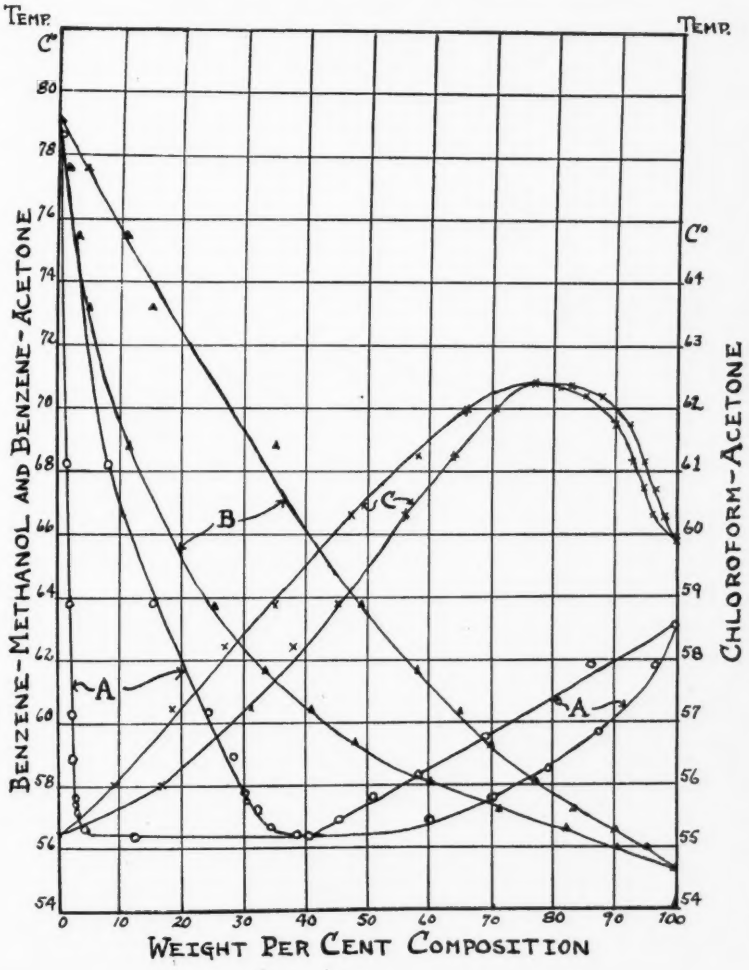
In the accompanying figure the data given in Table I is represented graphically. The curves marked *A* refer to the system benzene–methanol, those marked *B* to the system benzene–acetone, and those marked *C* to the system chloroform–acetone. The temperatures to the left of the diagram refer to the systems benzene–methanol and benzene–acetone, while those at the right of the diagram refer to the system chloroform–acetone.

Discussion

The method for plotting the boiling-point curves given in this paper is not a precision method. Errors inherent in the apparatus, procedure, and analysis prevent that. The error in reading the refractometer may be as high as 1.0–1.5 per cent, but in general these errors are from 0.3–0.6 per cent with the liquids used in these experiments.

Choice of the liquids to be used depends on the cost of materials, the boiling points of the pure liquids and of the azeotropic mixtures, and on the respective refractive indices. If the range between the boiling points of the pure liquids and the azeotropic mixture is not several degrees at

least, the resolution of the temperature-composition curves is not great enough to show any appreciable difference. There must also be a considerable range in the refractive indices of a given liquid pair in order to



obtain accuracy of analysis since the instrument is not accurate to more than five in the fourth decimal place. This range in the refractive indices then should be about one in the first decimal place.

The time required for a complete determination is about three hours.

One student can analyze the samples as fast as they are obtained by a second student who conducts the distillation.

Graphs for different determinations on the same system are very much alike in general characteristics, but frequently they cannot be exactly superimposed. As a consequence, the values for the azeotropic temperature and composition are not always the same. In Table II typical experimental values are compared to those given by Lecat.[2]

TABLE II

System	Azeotropic Temperature		Azeotropic Composition		Barometer
	Obs'd.	Ref.	Obs'd.	Ref.	
Acetone–Chloroform	62.4°	64.5°	20.0%	20.5%	732.0 mm.
	61.95		15.0		716.5
	62.25		14.0		719.0
Chloroform–Methyl acetate	62.6	64.8	56.0	77.0	717.5
	63.0		50.0		726.3
Methanol–Benzene	56.7	58.34	38.0	39.5	725.5
	56.7		38.0		737.0
Methanol–Carbon tetrachloride	54.2	55.7	21.0	20.56	718.0
	54.5		23.0		734.0

In column 1 the name of the system is given. In column 2 some experimentally observed azeotropic points are compared to the reference values in column 3. Column 4 gives the azeotropic compositions in weight per cent of the first-named constituent in column 1, while the corresponding reference values are given in column 5. In the last column the barometric pressures under which the distillations were performed are given.

It has long been recognized[10] that the composition of constant-boiling mixtures is dependent on a number of factors. We are, nevertheless, unable at present to account for the wide difference in the composition of the azeotropic mixture of chloroform–methyl acetate as found by us and as given by Lecat. In each of the other cases, however, the agreement of observed and reference values is fairly good.

[10] Briggs, *J. Phys. Chem.*, **28**, 644 (1924).

World Mineral Bankruptcy was prophesized by Sir Thomas H. Holland, Principal of Edinburgh University, in an address to the Mining Institute of Scotland. The total quantity of mineral consumed since 1900 exceeded that which was consumed in the whole history of the world before that year, and their destruction was even greater than before, because they were tending now to use only the rich deposits which satisfied their essential large-scale operations.—*Chem. Age*

VISUAL AIDS IN CHEMICAL EDUCATION*

III. Minimum Equipment for Visual Education in Secondary Schools

Visual educational is not new. Its types fall into two groups: (1) real objects or activities themselves, and (2) representations of objects or activities. The first of these groups includes demonstrations, experiments, and excursions or school journeys by which experience is gained at first hand. The second includes illustrative materials and devices by which experiences are gained vicariously. Examples are pictures in textbooks, flat pictures, stereographs, lantern slides, motion pictures, specimens, models, charts, and dramatizations. These visual and sensory aids help to supply a common basis of experiences for both teacher and pupil through which words arouse meaningful mental images. For the most effective teaching, care must be used in the selection, organization, and presentation of each of these aids at its appropriate time.

Within the scope of this article we shall attempt no discussion of teaching methods. Instead we shall limit our attention to the problem of minimum equipment needed for picture projection.

There are seven aspects to the problem:

I. Projection apparatus for still pictures;
II. Projection apparatus for motion pictures;
III. Suitable projection screens;
IV. Electrical outlets;
V. Proper devices for darkening the room;
VI. Projector stands;
VII. Library and storage facilities.

I. Still Pictures

A. Lantern Slides. The lantern slide (a transparency on glass) is the oldest form of object used for projecting pictures and from the standpoint of quality of image, brilliancy, etc., is unquestionably the most efficient. Because of the light being projected through it there is little loss of light so that it can be projected in a room with subdued light, there thus being sufficient light for making of notes, maintaining of discipline, etc. Lantern slides may be either black and white or colored. They may be secured from various commercial organizations which make a business of making up sets of slides on various subjects, or they can be very easily made. It is quite conceivable even that the making of slides for the use of the various departments of the school might be one of the projects of the chemistry laboratory. In this way tables, charts, diagrams, etc., might be copied and the slide filed for future use. Drawings may be easily made directly on clear glass slides. A committee might be appointed to survey the requirements of the science departments and carefully build up a library of slides that would be invaluable.

* This is the third of a series of articles from the Committee of the Division of Chemical Education of the A. C. S. on Aids to Visual Instruction in Chemistry. See THIS JOURNAL, **7**, 828–33, 1113–4 (1930).

Satisfactory lantern slide projectors can be secured from the manufacturers of projection equipment or through special agencies selling visual educational material, the standard sort of equipment being one of a fairly portable character, so that it might be easily transported from room to room, equipped with a 500-watt 110-volt Mazda lamp, a substantial double slide carrier and a projection lens of approximately $2^5/_{16}''$ free diameter of $12''$ focus. Different types of supporting bases are made but any one of the various equipments offered will give entirely satisfactory results and the equipment described is considered as most suitable for the average classroom. It is perfectly simple in operation and the price is around $70.00. For classroom use such a projector would produce a picture approximately $6'$ wide at a distance of about $25'$ from the screen, and therefore screens of the order of $6'$ in width should be provided. Three or four such equipments at least should be available in every high school so that they may be used in any room where still pictures are to be projected.

B. Film Slides. There has recently come into some usage still pictures made up on strips of film. One size is that on the regulation 35-mm. motion picture film to be used on either an especially designed projector or with an attachment in conjunction with the lantern slide projectors as mentioned above. These devices have sprocket wheels engaging in the standard perforations of the 35-mm. film, and the film is run through these devices vertically. The size of picture projected is that of the standard motion picture film aperture.

There is another type of film slide available which is made on a considerably wider strip of film, and is used in conjunction with a special holder substituted for the regulation lantern slide holder on certain lantern slide projectors. This film is then run through between two glass plates being wound from one spool on to another.

In either case the pictures must of necessity be shown in the sequence in which they are arranged on the film, and while perfectly satisfactory for set lectures they do not present quite the flexibility that the single picture on glass slides possesses. The film slides, particularly the smaller size, must of necessity be magnified more than in the case of the lantern slide; consequently, the picture is less brilliant and the quality of image hardly equal to that of a first-class lantern slide. The small size is not as readily colored as is a standard lantern slide.

Special projectors of small size and special design employing approximately a 200-watt lamp as a light source are made by several manufacturers, and special attachments for use on lantern slide projectors in place of the regular lantern slide projection lens are made by at least two manufacturers. From many standpoints the school should consider the purchase of an attachment to be used in conjunction with a lantern slide

projector rather than an especially designed projector, the use of which is limited to the 35-mm. film only. These especially designed projectors, however, have a very definite field for use of traveling lecturers or demonstrators such as county agents, sales organizations, etc.

Material for use on the 35-mm. film slide projectors can be secured from several commercial organizations putting out such pictures for educational and commercial purposes, and a number of commercial organizations are supplying such pictures either free or on a small charge basis, which, while to a certain extent of an advertising character, are nevertheless often valuable for educational use. The Department of Agriculture also has these films available on many subjects. The wide film referred to, which can be used by means of a special carrier in the regular lantern slide projector, is produced by the Still-film Company of Los Angeles, the only company producing such film at this time. Generally speaking, it is suggested the use of film slides should be considered as a supplementary class of illustrated material rather than a major class. Special projectors for this sort of material list at from $55.00 to $65.00 and attachments between $35.00 and $40.00.

C. Opaque Objects. The use of opaque objects for projection purposes has many advantages for classroom use but at the same time has its limitations. To project opaque objects such as photographs, diagrams, etc., one must have a projector especially designed for that purpose and, because such an object is projected by reflection, much light is lost because of that fact alone and further because the object is at the best a poor reflecting surface. This means, therefore, that opaque objects cannot be projected with the same brilliancy for a given light source as that of a lantern slide and consequently must be used at rather limited distances as compared with the maximum possibility of lantern slide projection. Also in order to offset the loss of illumination, the room in which an opaque projector is to be used should have facilities for totally darkening unless one uses a special design of projector for use in conjunction with a so-called "daylight" screen to be mentioned later on.

The opaque projectors from the classroom standpoint, and particularly in the science departments of the high school, have the advantage of making it possible for the teacher to use illustrations from current magazines, diagrams, and charts the students may prepare, small objects, etc. The cost of the material is almost negligible and many teachers have been able to keep their instruction up to the minute by using illustrations and current technical magazines, etc., which periodicals may be used only once and then discarded. The installation of an equipment for opaque projection, therefore, makes it possible in many cases for the teacher to use illustrative material whereas otherwise they would not be justified in the time or expense of making up even a lantern slide.

Opaque projectors are available with which lantern slides may also be projected. Consequently, it is recommended that the high schools should consider a combination opaque and lantern slide opaque projector to which a film slide attachment might also be added, particularly for use in the chemistry lecture room and, in the larger high schools, also in the physics and biology lecture rooms. These projectors in the small sizes are fitted with a 500-watt lamp and in the larger sizes with either a single 1000-watt lamp or two 500-watt lamps for illuminating the opaque object. Combination projectors will range in price from $110.00 up to $290.00. The selection will depend somewhat on the size of the classroom and the amount of money the school has to spend for such equipment, the high-priced and larger projectors having the advantage of being usable for greater distances, of giving more illumination, and projecting greater areas of the object. The manufacturers of such equipment will be glad to recommend to schools, if the schools will advise them of the conditions, the model best suited for their particular requirements.

For opaque projectors an aluminum-coated type of screen is desirable because of the greater brilliancy desired. The projectors mentioned above would be of the type projecting on a reflecting screen where sizes of pictures 6′ or more in size might be projected, which, as has been stated, necessitate a totally darkened room.

There is a second type of combination opaque object and lantern slide projector designed particularly for use in conjunction with a translucent or so-called "daylight" type of screen. This type of projector is used back of the screen, the screen being from translucent material. This sort of equipment possesses merit for use in rooms where facilities have not been provided for total darkening and makes it possible to have an equipment that might be used in different rooms. With such equipment it is customary to place it at one corner of the room, where light would be eliminated from striking the screen at the back, the projector thus facing the audience, and the image being formed on the translucent screen between the projector and the audience. This arrangement of necessity means a comparatively small size of picture, the customary size probably not exceeding 3′ wide. By virtue of this small size and the translucent material used as a screen, a picture of considerable brilliancy can be projected from an opaque object in rooms with subdued light. By taking care to see that the equipment is located on the dark side of the room and pulling the ordinary window shades, it is often possible to use such equipment with entire satisfaction in almost any classroom, provided the small size of picture is adequate for the farthest observer. Such equipments list for about $160.00.

D. Micro Projectors. A specialized form of projection equipment is one with which prepared microscopical slides may be used, this form of

projector being very valuable in the biology departments for projecting sections of plant stems, wings of insects, and similar material for class instruction purposes. Such an equipment could also be used at certain times in the chemistry department for showing crystallization, characteristic shapes of crystals, etc. Such an equipment will be found a very valuable supplement to the regular microscopical work in the biology departments since it enables the instructor, by means of typical slides, to make sure that the student, who is a novice in the use of the microscope, sees the structure that he should look for in the individual microscope work. Such projectors are offered over quite a price range running up to approximately $175.00. They operate most satisfactorily in conjunction with the 5-ampere arc lamp as the light source on 110-volt direct current circuits.

II. Motion Pictures

The motion picture projector using 16-mm. film is now recognized as standard classroom equipment. Its value has been clearly demonstrated by nation-wide tests of instructional results. Whereas a few years ago few of these narrow width films could be obtained, now special libraries of educational reels are being made available in a form adapted to the needs of the classroom. The projector should be a model which has been approved by the Board of Fire Underwriters, requiring no booth, licensed operator, extra-heavy electrical wiring, or added building insurance. Such approved 16-mm. projectors positively prevent the use of inflammable film because only safety film is made in 16 mm. width, whereas both inflammable and safety film are made in the 35 mm. width. So, by using a 16-mm. projector, there is no danger whatsoever from film fire. Such projectors equipped with a powerful 250-watt lamp are portable and so simple to operate that pupils manipulate them easily. The price of the 16-mm. portable projector is about $160.00.

For auditorium showing and for occasional use in the classroom a standard 35-mm. semi-portable machine may be added to the required list. However, the time is rapidly arriving when no classroom teacher need feel dependent upon film of 35 mm. width for the source of motion picture material. Even many of the industrial films are now available in both 16 and 35 mm. widths. The price of the semi-portable 35-mm. machine is about $400.00.

III. Screens

The quality of a projected picture is affected by the nature of the screen from which it is viewed. A poor screen surface will yield most unsatisfactory pictures even from pictures having beautiful quality. Good pictures cannot be obtained from a fine-quality screen if it has direct stray light impinging upon its surface. Therefore, in discussing the projection

screen, we must assume that the photographic print to be used is of the highest quality and that the classroom is properly darkened.

A projection screen for classroom use should be about 4 × 5′ in size. It should be inexpensive, should have a fairly wide angle because of the short distance from the screen of the first few seats at the front of the classroom. The roller type of screen, enclosed in a box so that it will roll up when not in use, will be most serviceable for classrooms in which pictures will be shown only once or twice a day. Such a screen can be hung easily by two screw-eyes from the upper blackboard molding. This also enables it to be taken from room to room and quickly put into position wherever pictures are to be shown. The size, 4 × 5′, enables a teacher to use the screen for either still or motion pictures. The question of angle is important. If a screen has a very narrow angle, it means that most of the light falling upon it from the projector is reflected directly back toward the projector, and very little to either side of a perpendicular line from the projector to the screen. A screen of very wide angle would give a picture of equal brilliance no matter from what angle of the room it is viewed, but the picture as a whole would be dull. So, one must choose a screen which has as wide an angle as possible and yet will give a brilliant picture for practically the whole area of the room. Furthermore, portability and cost must be considered. The cost of these screens is about $10 each.

The so-called "daylight" screens, that is, translucent screens, may be secured from different sources where special fabrics are manufactured or they may be made up using tracing paper, tracing cloth, or dental rubber stretched on a frame.

IV. Electrical Outlets

A base plug outlet should be provided in each room in which the lantern is to be used, with wiring and fuses preferably capable of carrying 1000 to 1500 watts so that in the event of the necessity arising for the use of a lantern requiring such wattage a suitable outlet would be available. Equipments fitted with lamps consuming up to 500 watts can be attached to the lamp socket outlet, but this is not ordinarily good practice because of the difficulty and time required to make such connection. Convenient outlets should therefore be provided in the baseboard at the rear of the room. It should be located a few inches from the floor so that cleaning solutions cannot enter the opening, thus short-circuiting the line. The outlet should be opposite the middle aisle, so that the electrical cord of the projector may extend down this passageway. The wire for the outlet should be enclosed in a metal conduit and should be on a separate circuit from that of the classroom. A 10-ampere capacity line, either a. c. or d. c., at 110–115 volts, would be most serviceable. The outlet should

be flush with the board or wall surface and should be a two-way receptacle. A second outlet at the front of the room has occasional use.

V. Room Darkening

Brilliant quality in motion pictures, depicting details in the high lights and shadows of the picture area, can be shown only in an adequately darkened room. The most satisfactory equipment for projection should provide for the darkening of the room to the point where it is still possible for pupils to read large print, and so that no direct light falls upon the projection screen. In the usual classroom there are no windows on the pupils' right. Generally, these windows are provided with shades, unless the classroom is on the north side of the building. The shades should be of an opaque, not translucent material. The color of the shade does not matter; however, a light-colored opaque shade is preferable to a dark one, as it gives a pleasing room appearance. The sides of the shades should closely fit the window casings and when drawn up or down should fit closely to the upper casing or windowsill as the case may be. Some schools use an extra shade covering two small windows at once when drawn. A sheath may be provided at the side of this wide curtain so that practically all of the stray light is excluded. This provides a simple, inexpensive means of adequately darkening a classroom.

VI. Tables

While it is the practice in some schools to use the student's desk as a supporting table, particularly in the case of the small portable lantern slide projectors, as a general thing that should be avoided because the lantern is not supported at the correct height, the top is not level, and generally it is not good practice. A suitable supporting stand either permanently installed, if the location of the lantern is such that it need not be removed, or a stand which can be readily moved from room to room should be procured for each lantern. They are provided with a shelf underneath for boxes of slides or reels of films and are made narrow enough for use in classroom aisles. Such stands are available through several manufacturers, or the manual training department of the high school might, as a special project, build a suitable stand.

VII. Library and Storage

Just as, for instance, a teacher of geography has her sand tables, exhibit cupboards, map cabinets, and so forth, so the modern classroom teacher has at her disposal the pictorial materials which pertain directly to the classroom instruction in her particular subject. If this supply is located in the school library, then any classroom teacher in the building can easily and quickly secure that material which she needs for class

instruction. Filing cases will there be provided for collections of lantern slides, flat pictures, stereographs, and motion pictures. With the addition of a few rods the common metal locker may be made a safe and convenient cabinet for the storage of films.

Boards of education have been late in realizing that a rental system leaves the school with no permanent property and the use of industrial or commercial free films subjects the school to criticism. Free films are not always free from propaganda. Many strictly educational agencies are now at work planning so that small school units may have access to a great variety of visual aids. Local museums, in coöperation with the city schools, great state universities, state museums, and libraries are extending their service so as to include many new aids.

The high cost of sound equipment forbids its inclusion as minimum secondary school equipment even for auditorium use. The development of educational "talkies" appears to be in the direction of the lecture type of demonstration. In the college or the university where the lecture system prevails there is likelihood of rapid increase in the use of sound equipment. It is hardly necessary to add that no form of visual aid, nor all forms taken together, can be thought of as displacing the teacher.

Flow of Liquids Due to Molecules. The cause of the resistance to flow possessed by a liquid has been discovered by Prof. G. W. Stewart of the University of Iowa and his co-workers to be due to small groups of molecules within the liquid.

Several decades have passed since the physicist has adopted the existence of the atom and molecule as a known fact. In the gaseous and crystalline states, the action of these minute particles of matter is relatively well understood. But in the liquid state little has been known concerning the relation of the molecules one to another.

Prof. Stewart was able to demonstrate that the molecules of liquid are not independent in action. They do not vibrate separately and individually under the application of heat. On the contrary, the molecules form small aggregates containing perhaps a hundred or more arranged in a fairly orderly manner, but not with sharp, well-defined boundary lines.

Thus the liquid shows an organization of molecules, somewhat as in a crystal, yet with a state of flux not only between but even actually in these aggregates. In some aggregates long molecules have their closest association end to end, and in others, side by side.

Prof. R. L. Edwards of Miami University collaborated in determining that there is a relation between the size of these small groups of molecules and the friction resistance to flow possessed by a liquid. Heretofore the understanding of such frictional effects was seriously hampered because no one knew how to treat the effect of the molecular forces upon this frictional resistance.

These researches now open the way to a better understanding of the nature and causes of the viscous resistance in liquid flow. They lead to a better fundamental understanding of the physical nature of a liquid.—*Science Service*

THE ATLANTA MEETING

Report of the Secretary of the Division of Chemical Education

Over 1400 chemists and guests attended the 79th Meeting of the American Chemical Society in Atlanta, April 7th–11th. With minor exceptions the program was carried through as announced in the March 20th *News Edition* of *Industrial and Engineering Chemistry*. [The Division program appeared in the April issue of THIS JOURNAL, **7**, 904–6 (1930).] The character of papers presented, the beautiful weather, and an elaborate program of entertainment caused the unexpectedly large number of guests to come early and linger until the end, but the generous hospitality of the Georgia Section and of the citizens of Atlanta never wavered.

Although much of the business of the Division was transacted by the Executive Committee, the Senate met to consider committee reports and the Division held a meeting at the close to dispose of final items of business.

The Division devoted four sessions to the reading of 29 papers. On Wednesday, April 9th, the program was dedicated specifically to Chemical Education in the South. Papers invited for the morning session dealt with some historical aspects and the problems now facing the teaching profession, while the afternoon session was devoted to a joint symposium with the Cellulose Division on The Relation of Chemistry to Cotton. Attendance exceeded 200 at times during the symposium.

Wednesday noon over 100 attended the luncheon which, through the courtesy of Mr. Wm. W. Buffum, was complimentary to high-school teachers of chemistry in the Atlanta area. Following the luncheon *Chairman* SWAN introduced the following to our guests: *Superintendent* WILLIS A. SUTTON of Atlanta, WM. MCPHERSON, *President* of the A. C. S., WM. W. BUFFUM, *Business Manager* of the JOURNAL and *Leaflet*, NEIL E. GORDON, *Editor-in-Chief*, PAULINE BEERY MACK, *Associate Editor*, and CHARLES H. HERTY. Each responded briefly and the occasion proved most delightful in every respect.

M. A. Gaertner, Local Secretary of the Division, had been responsible for sending announcements and invitations to about 1500 secondary science teachers within a radius of 200 miles of Atlanta. This general plan has been followed for several years and has resulted in noticeably greater professional activity among teachers in the areas covered.

Wednesday evening the editors of the JOURNAL and *Leaflet* met at dinner to discuss the editorial policies of these two divisional publications. The following were present:

NEIL E. GORDON, *Editor-in-Chief;* PAULINE G. BEERY MACK, *Associate Editor;* WM. W. BUFFUM, *Business Manager;* H. C. SHERMAN, LYMAN C. NEWELL, WILHELM SEGERBLOM, and R. A. BAKER, *Departmental Editors;* C. A. BRAUTLECHT, FRIEND E. CLARK, J. SAM GUY, T. R. LEIGH (proxy for A. P. BLACK), R. K. MCALPINE, R. N. MAXSON, W. F. RUDD, J. N. SWAN, and G. H. WHITEFORD, *Contributing Editors.*

About thirty students took advantage of the special student housing facilities provided by the Local Secretary of the Division; the largest group being one of ten who drove through from Syracuse, New York. This feature is growing in popularity. The Division hopes to stimulate the attendance of a much larger number of undergraduates and graduate students at the Cincinnati Meeting next September.

Minutes of the Meetings of the Executive Committee

8.00 A.M.–2.00 P.M., April 7, 1930, and 8.30–9.30 A.M., April 10, 1930

Present: J. N. SWAN, *Chairman;* R. A. BAKER, *Secretary;* WILHELM SEGERBLOM, *Past Chairman;* NEIL E. GORDON, *Editor-in-Chief;* WM. W. BUFFUM, *Business Manager;* and M. A. GAERTNER, *Local Secretary.*

REPORTS OF OFFICERS

1. **Chairman:** The Chairman announced the personnel of recently appointed committees and referred particularly to the joint committee on Organic Nomenclature.

2. **Secretary:** The Secretary reported that there are now 223 active members, classified as follows: college teachers 67%, high-school teachers 14%, industrial chemists 9%, college students 3%, unclassified 7%. There are 332 associate members, classified as follows: high-school teachers 57%, college teachers 12%, college students 9%, industrial chemists 4%, high-school students 4%, unclassified 17%.

The Secretary also described certain details of the Atlanta program and outlined tentative plans for the Cincinnati meeting.

3. **Editor-in-Chief:** The Editor reported for the JOURNAL and the *Leaflet* and requested expressions of opinion concerning certain policies. The committee favored (*a*) reprinting for distribution the list of periodicals abstracted by the JOURNAL [**7**, 957–70 (Apr., 1930)] and (*b*) including reviews of foreign books in the proposed index of book reviews. The committee did not favor (*a*) printing more than one annual index for those who wish to bind the JOURNAL in two volumes per year, or (*b*) reprinting frontispieces at present since the plates are being held anyway.

4. **Business Manager:** The Business Manager reported that the total number of subscribers to the JOURNAL is now 10,383, of whom 1349 are chemistry teachers who have been subscribers for two or more years. The Committee discussed the function and size of the JOURNAL and the possible methods of reaching more teachers. No definite decision was reached although it was agreed that a survey should be made (see item No. 2 under New Business).

Subscriptions to the *Chemistry Leaflet* have grown from 1266 in October, 1929, to 6718 in April, 1930. The majority of these are group subscriptions by chemistry classes.

5. **Local Secretary:** The Local Secretary reported upon the details of the program and entertainment for the current meeting.

REPORTS OF COMMITTEES

Mimeographed copies of committee reports had been prepared for presentation to the Senate and were considered briefly by the committee (*cf.* Minutes of the Senate Meeting, page 1351). Specific requests from committee chairmen were disposed of as follows:

1. Voted to grant to Committee on Chemical Education by Radio, up to $100.

2. Voted to recommend that the Committee on Chemical Education of the Non-Collegiate Type confine its efforts for the present to a consideration of (*a*) the advisability of high-school boys taking up routine industrial work, and (*b*) the type of training they should have for such positions.

3. Voted to allow the Committee on Minimum Equipment for High-School Chemistry an item of $10.00 for postage, etc.

4. The question of changing the name of the Committee on Visual Aids was referred to the Committee on Naming and Scope of Committees.

5. Voted to allow an item of $29.26 which had been expended by the Committee on Professional Spirit among High-School Teachers.

6. Upon recommendation of the Committee on Professional Spirit among High-School Teachers, it was voted to discontinue the committee. Appointed in 1928, this committee has been exceedingly active in surveying the field and organizing its program. The Secretary was directed to convey to the Chairman, Dr. L. W. Mattern, the appreciation of the Division for the loyal, conscientious, and efficient service of his committee.

NEW BUSINESS

1. It was the sense of the committee that for the present the Division is not in position to finance fellowships.

2. Voted to appoint a committee to study and prepare a report upon the subscription lists of the JOURNAL OF CHEMICAL EDUCATION. N. E. Gordon and R. A. Baker were appointed on this committee by the Chairman.

3. The committee approved the practice of arranging a luncheon for local high-school teachers at each general meeting.

4. The committee discussed the equivalence of laboratory and recitation work in computing the teaching load and voted to go on record as opposed to the practice of allowing less credit for laboratory than for class work. It feels that, when the instructor's full time and energy are put into each, one hour of laboratory work is the equivalent of one hour of recitation or lecture work.

5. The committee approved the appointment of Father E. J. Morgan as Local Secretary of the Division for the Cincinnati Meeting.

6. It was voted to discontinue the practice of allowing subscribers to the JOURNAL two free advertisements yearly.

Minutes of the Meeting of the Senate of Chemical Education

8.30 A.M. Wednesday, April 9, 1930

Present: J. N. SWAN, *Chairman;* R. A. BAKER, *Secretary; Alabama Section,* JAMES T. MACKENZIE and JOHN R. SAMPEY; *Arkansas Section,* HARRISON HALE; *Colorado Section,* ROBERT COLLIER, JR. and G. H. WHITEFORD; *District of Columbia Teachers Association,* GEORGE E. COYLE; *Florida Section,* TOWNES R. LEIGH (proxy for V. T. JACKSON) and C. F. SPEH; *Kentucky Association of Chemistry Teachers,* R. N. MAXSON; *Maryland Section,* E. EMMET REID; *Mississippi,* JOHN N. SWAN; *University of Missouri Section,* K. KERSHNER; *New England Association of Chemistry Teachers,* G. J. ESSELEN, JR., C. A. BRAUTLECHT, FRANK M. GREENLAW, LAURA P. PATTEN, WILHELM SEGERBLOM, P. CONANT VOTER; *New York,* R. A. BAKER; *Pennsylvania,* PAULINE B. MACK (proxy for A. J. CURRIER) and W. B. MELDRUM; *West Virginia Section,* FRIEND E. CLARK; *National Research Council,* J. E. MILLS (present by invitation).

REPORTS OF OFFICERS

1. The Secretary reported that there are now 174 members of the Senate, distributed in 45 states and representing 43 Local Sections of the A. C. S. and 13 associations of chemistry teachers.

REPORTS OF COMMITTEES

1. **Naming and Scope of Committees:** WILHELM SEGERBLOM, *Chairman,* presented the following report which was approved:

Since the meeting of the Executive Committee of the Division of Chemical Education at New York City, last January, the committee on Naming and Scope of Committees has officially approved the names of the following committees: 1. **Chemical Education of the Non-Collegiate Type.** 2. **Chemical Education by Radio.** 3. **Chemistry Clubs.** 4. **Chemistry Libraries.** 5. **Correlation of High-School and College Chemistry.** 6. **Labels.** 7. **Organic Nomenclature** (Joint committee with Organic Division). 8. **Teacher Exchange.** All of these Committees except Numbers 3 and 8 were listed on the page following page 728 in the April, 1930, issue of THIS JOURNAL.

The heavy part of our work has been in determining what aspects of the problems most needed investigation, in formulating possible lines of attack each new committee might follow, and in listing such references and helps as had been suggested by various persons. All this information, together with a statement of how the problem came to our attention, was sent to the chairman of the Division to pass over to each new committee. This was done, not with any idea of dictating to the new committee or of

limiting it in its investigation, but it was done in the spirit of wishing to put at its disposal all material which had come to light during the steps which led up to the appointment of the committee.

The request of Dr. Harrison Hale for the addition of the "names of some women of national importance" to his committee on **Women's Club Study Course in Chemistry** was referred to us and we have supplied the chairman with a list of names.

The committee on **Organic Nomenclature** is listed in THIS JOURNAL as a joint committee with the Organic Division, because Dr. Whitmore wished to have our chairman select two persons to represent our Division on his committee.

Following the vote at the New York Meeting of the Executive Committee to instruct the Mack Printing Company to knock down the type of the articles collected for reprinting by the Committee on **Research Problems of High-School Chemistry Instruction,** the question of abstracting or collecting these articles was referred to our committee. Some members of our committee favored having these articles abstracted for the Abstract section of THIS JOURNAL, but this does not seem feasible as it has recently been learned that a forthcoming book will contain the abstracts of all recent articles dealing with chemistry instruction.

Our committee was unanimous in feeling that Dr. Glenn's list should be made available in some way. Our committee, therefore, recommends that the Executive Committee instruct the Editor to print Dr. Glenn's list (including title of article, name of author, and issue reference) in the JOURNAL provided it does not occupy more than a page and a half. This recommendation concerning the list of articles on chemistry instruction was adopted. (This list will be published later.)

We appreciate the addition to our committee of the Secretary of the Division as an *ex-officio* member and are glad to report him as an active and very helpful member.

2. **Chemical Education by Radio:** ROBERT F. MCCRACKAN, *chairman,* presented the following progress report which was approved:

During the two months since the formation of this committee, its main work has been to collect information concerning education in general by radio and concerning chemistry in particular, from such sources as the Ohio School of the Air, the Payne Foundation Report, and the Federal Radio Commission. Plans are being made to complete the survey.

3. **Chemical Education of the Non-Collegiate Type:** The following report was received by letter from R. E. BOWMAN, *chairman,* and was approved.

The writer wishes to express his regret at the resignation of Dr. Allen Rogers from the chairmanship of this committee and his own limitations in taking up the work. He pleads only his great interest in secondary education, especially the neglected field of non-collegiate chemical education. His greatest concern is that the door through which Michael Faraday and Edwin Hart and many others have entered scientific work shall never be closed, and that genius shall be rewarded as quickly in laboratory and plant as in the classroom.

This committee is not as yet ready to make a formal report. The writer believes that they will support him in urging that the work of the committee on **Chemical Education by Radio** be broadened to include all extension and publicity work—radio talks, Institute lectures (such as the delightful ones given last Christmas holidays by Dr. Holmes of Oberlin at Franklin Institute), newspaper articles, etc., and that our own group should confine its studies to the strictly vocational phases—technical institutes, correspondence, night schools, Smith-Hughes class work, training classes conducted by corporations and trade associations, and lastly, the use and effect of the widespread Chemcraft and similar sets. Over sixty thousand boys per year get an inkling of chemistry through these.

The Society for the Promotion of Engineering Education is soon to publish a study by Mr. Robert H. Spahr of General Motors Institute of Technology, of the Technical Institute Area of Education. Mr. Spahr writes me that there are about forty technical schools of this type in the United States, "some of them are institutions working solely in this field, others are universities giving special courses of this type, and still others are correspondence schools of the type of the I. C. S." Our committee will be greatly assisted by this study, and it is fortunate in having as members Dr. Rogers, whose school is chosen as typical in the above study, and Mr. Lawrence of the International Correspondence School.

Schools like those mentioned above are the true "upgrading schools" to which workers from industry can be sent, rather than the college or university which would bar most of them for lack of conventional college entrance credits. Lack of time and money operate to bar such students from any but intensive courses.

The writer is gaining many contacts through letters referred to him by Dr. Parsons, Dr. Baker, and others. All of these he is answering as rapidly as he can find time. Many contacts with trade associations must be made as soon as possible. The writer trusts that the committee may be able to report a consistent program at the time of the September meeting of the society.

4. **Correlation of High-School and College Chemistry:** NEIL E. GORDON, *chairman*, presented the following report which was approved:

This committee is now working upon certain plans for ascertaining the extent to which modification of the present plan is needed. Since the present minimum essentials are the result of such a vast amount of long and careful work and wide approval, the committee is of the opinion that alterations must be handled in the same manner and hence require considerable preliminary work.

5. **Labels:** The following report was received by letter from JOHN M. MICHENER *chairman*, and was approved:

We are compiling a list of possible formulas which should appear in the label book with the intention of sending out copies of this to a large number of colleges and high schools, requesting them to indicate which ones they would like to see printed.

One of the present label books on the market is being revised, and the revision is following suggestions made by our committee. Most of the various laboratory supply companies have signified their willingness to coöperate with the committee in improving the label books which are now on the market.

6. **Major Topic Organization of High-School Chemistry:** The following report was received by letter from H. A. CARPENTER, *chairman*, and was approved:

To date I have reports from each member of the committee except one, giving results of their first study of the tentative organization, and also comments by Wilhelm Segerblom and R. A. Baker. Judging from these reports it appears that the objectives in the main are sound. It seems also that the tentative organization as presented has certain desirable features but that the whole course now needs careful revision by the committee before presenting it, or any portions of it, to a wider group for criticism.

The course has been followed out with certain classes at West High School, Rochester, New York, as a result of which certain changes will be recommended for consideration of the committee as a whole. It is hoped by the chairman that this revision work may be carried on somewhat vigorously in the next few months in order that a revised organization may be presented at the September meeting of the Senate.

7. **Minimum Equipment for High-School Chemistry:** The following report was received by letter from J. H. JENSEN, *chairman*, and approved:

On the basis of suggestions received to date (March 30th) a revised list of minimum equipment for the use of the individual pupil has been prepared. Only the items most

frequently used by the pupil are included. Such items as glass tubing and burets will be placed in the list of general apparatus to be issued from the stockroom when needed. Other items may well be included in this list also such as thermometers, files, graduates, etc. These items are so indicated on the list. The committee would appreciate a frank statement as to desirable changes, additions, or items that may well be dropped from this list. Note that the committee has attempted to standardize on size of tubing for funnel tubes to correspond to glass tubing, holes in cork specified for 6-mm. tubing, size of opening in wide-mouth bottle, Erlenmeyer flask, and 8-inch Pyrex test tube to take no. 5 rubber stopper, etc. This will reduce the number of items necessary to supply to the pupil.

The chairman desires to express his thanks for the helpful suggestions received from the members of the Executive Committee and from the members of the committee on Minimum Equipment. As soon as this list is returned to the committee, we shall have some material on chemicals to present for the consideration of the Senate of Chemical Education.

8. **Order of Presentation of Recitation and Laboratory Work:** FRANK M. GREENLAW, *chairman*, reported upon a special investigation just completed at the Rogers High School in Newport, Rhode Island, the results of which appear in full in THIS JOURNAL, pages 1355–63.

9. **Preparation of High-School Chemistry Teachers:** In the absence of the chairman, PROFESSOR HENRIETTA HAYDEN presented the third formal report of this committee which deals with the Training of Teachers of Chemistry in Secondary schools in some foreign countries. The report was accepted and appears in THIS JOURNAL, pages 1363–6.

10. **Professional Spirit among High-School Teachers:** LOUIS W. MATTERN, *chairman*, presented by letter a formal report which was accepted and appears in THIS JOURNAL, pages 1366–70.

11. **Visual Aids in Chemical Education:** M. V. MCGILL, *chairman*, reported by letter that the published outline of the committee's activities is being followed. [THIS JOURNAL, **7**, 828–33 (Apr., 1930).] See this issue, pages 1341–8.

12. **Women's Club Study Course in Chemistry:** HARRISON HALE, *chairman*, presented the following report which was approved.

This committee begs to report the publication of the course in the February number of THIS JOURNAL [**7**, 325–40 (Feb., 1930)]. Five thousand reprints have been prepared for club use.

Wide publicity was given the course by the News Service of the A. C. S. at the time of the Minneapolis meeting. The interest aroused then has continued and numerous inquiries have been received.

Through the help of the Chemical Foundation a wonderfully attractive price has been made on the books needed and the Bureau of Women's Clubs, University of Arkansas, has agreed to have this price cover the registration fee also.

Letters are being sent to as many clubs as can be reached and to a selected list of chemists asking their help in bringing the course to the attention of women who might be interested.

The committee has been decidedly strengthened by the addition to its membership of Mrs. John D. Sherman, Denver, Colorado, former president of the General Federation of Women's Clubs, who has been deeply interested in this work from the beginning; of Mrs. Pauline Beery Mack, State College, Pennsylvania, Editor of the *Chemistry Leaflet;* and of Miss Clara de Milt, H. Sophie Newcomb College, New Orleans.

The committee earnestly requests the help of each member of the Society in bringing this course to the attention of women in his vicinity.

NEW BUSINESS

1. The Secretary distributed in mimeographed form an analysis of the recent Senate letter ballot. It was voted to interpret this ballot as favoring concentration upon the work of the following committees: (*a*) **Women's Club Study Course in Chemistry,** and (*b*) **Minimum Equipment for High-School Chemistry.**

This concentration is not to be considered as an indication of relative importance and does not mean that other committee work will be dropped or even deferred. The committees in question have brought their programs to a point where nation-wide effort is needed to push them over the top.

2. The appointment of a new committee on **Examinations and Tests** was favorably considered and was referred to the committee on **Naming and Scope of Committees.**

3. The appointment of a new committee on **Teaching Load** was referred to the committee on **Naming and Scope of Committees.**

4. It was voted to approve the recommendation of the committee on **Naming and Scope of Committees.** (See committee report No. 1, page 1351, with regard to the disposal of the material that was collected by the committee on **Research Problems of High-School Chemistry Instruction** and which has been held in type by the Mack Printing Company.)

5. It was voted to authorize the committee on **Women's Club Study Course in Chemistry** to seek the coöperation of the Federation of Women's Clubs.

Adjourned 10.15 A.M.

Minutes of the Business Meeting of the Division of Chemical Education

Present: J. N. SWAN, *Chairman;* R. A. BAKER, *Secretary;* A. L. BARKER, J. W. BARKER, C. A. BRAUTLECHT, S. R. BRINKLEY, SISTER M. AUGUSTANA BROBSTON, ROBERT COLLIER, JR., FRANK M. GREENLAW, HARRISON HALE, C. C. HEDGES, E. V. JONES, WM. M. LOFTON, JR., R. N. MAXSON, ROBERT F. MCCRACKAN, SISTER MARY ROSE MURRAY, EARL W. PHELAN, P. ROBERTSON, ARTHUR ROSE, W. T. SCHRENK, EWING C. SCOTT, WILHELM SEGERBLOM, G. H. SHADINGER, P. T. STONE, A. STRICKLER, P. C. VOTER, G. H. WHITEFORD, N. WALKER WRIGHT.

1. The Secretary reported briefly upon the recent meetings of the Executive Committee and the Senate, and upon certain details of the Atlanta program.

2. It was voted to convey to M. A. Gaertner the thanks and appreciation of the Division for his consistent and efficient service as Local Secretary.

3. Professor Henrietta Hayden, chairman, reported for the resolutions committee as follows:

Resolved: That the Division of Chemical Education of the American Chemical Society cast a ballot thanking the Georgia Section for their most cordial hospitality which has been extended during the convention held in Atlanta, April 7–11, 1930.

The resolution was unanimously adopted.

Adjourned 11.30 A.M.

R. A. BAKER, *Secretary*

RECITATION OR LABORATORY FIRST*

A report of a comprehensive research to determine whether the precedence of laboratory work or recitation gives better results in teaching high-school chemistry was presented by Dr. Rosalie M. Parr at the Minneapolis meeting of the American

* A progress report of the Committee on Order of Presentation of Recitation and Laboratory Work, read before the Senate of Chemical Education at the Atlanta Meeting of the A. C. S., April 9, 1930.

Chemical Society in September, 1929.[1] The broad scope of this investigation, and the detailed analysis of the results obtained, appear to establish the conclusive character of the findings which were stated. The results of all experimental investigations, however, even in education, should be reproducible; and confirmatory tests add to conviction. With this thought in mind, a limited investigation of similar character has been carried out during the current school year at the Rogers High School in Newport, Rhode Island.

If objection should be raised that the results were obtained at only one school and from the consideration of only one topic, it should be borne in mind that the scope of this test was purposely limited in order to exclude the variables of difference in environment and mode of presentation of different teachers which are inevitably present where a large number of schools coöperate in the same undertaking.

General Conditions of Experiment

The test was made early in the school year while the pupils were accumulating the fundamental facts upon which the structure of chemical knowledge must be based and before the pupils had developed a definite "set" in regard to the acquisition of new material.

The unit chosen was "Water" which lends itself well both to experimental and to descriptive treatment. Lesson sheets were prepared which contained all the material upon which the pupils were finally to be examined. Textbooks were used only for supplementary reading. The directions for laboratory experiments and for the written reports of these experiments were given in full detail and were identical for all pupils.

The tests given to the pupils when the study of the unit had been completed were of the objective type. These examinations were designed to measure only the factual knowledge, or range of information, possessed by the pupils at the conclusion of their study of the assigned unit and the extent to which this knowledge was retained after an interval of four weeks, during which several additional topics had been studied. This relatively short interval was chosen because of the rapid growth in ability to assimilate new facts and principles in chemistry which most students manifest in the early weeks of instruction.

One hundred and two pupils, in four divisions of twenty-five or twenty-six each, were placed in two groups which, for convenience, were designated as Recitation First and Laboratory First. An assignment from the lesson sheet was given to the Recitation First group; the facts and principles involved were discussed by the instructor; and demonstration experiments were performed as needed. At the following exercise, the assigned matter was made the topic of the usual oral recitation exercise. On the next day, the pupils went to the laboratory for individual laboratory experimentation, with a clear knowledge of the procedure to be followed and also of the results to be expected.

The Laboratory First group was instructed to read in advance the directions for the laboratory experiment. On coming to the laboratory, they were shown a "set-up" of the apparatus to be used and the instructor stated briefly the limited problem whose answer was to be found by performing the experiment. The pupils were then left to their own resources, with only the customary advice and brief questioning of the instructor as he moved about the laboratory supervising the work. At the conclusion of the laboratory exercise, an assignment was made from the lesson sheets. On the following day an oral recitation was held on the results of the experiment and on the related material contained in the assignment. In every laboratory period the pupil

[1] Parr and Spencer, "Should Laboratory or Recitation Have Precedence in the Teaching of High-School Chemistry," THIS JOURNAL, 7, 571–86 (Mar., 1930).

worked from printed directions without previous classroom discussion of the results or significance of the experiment.

Tests

At the beginning of the experimental investigation, the Terman Group Test of Mental Ability, Form A, was given to each student registered in chemistry. For the Recitation First group scores ranged from 107 to 200, with a median of 154. Intelligence quotients for this group ranged from 91 to 124, with a median of 106. For the Laboratory First group the Terman scores ranged from 72 to 205, with a median of 147. Intelligence quotients for this group ranged from 79 to 120, with a median of 103. There was therefore a small difference in average ability in favor of the Recitation First group.

Tests to measure the factual knowledge of the unit studied were prepared in two equivalent forms. A rather large number of questions, thirty in all, was used in order to have the sampling as complete as possible. Fifteen of these questions were of the multiple response type (four or five responses) and were scored either right or wrong. Ten questions were of the true-false type and were scored number right less number wrong. The remaining five were of the multiple statement type, involving a recognition of classification and logical relationship. These latter were given double credit, making the score for a perfect paper thirty-five points.

These achievement tests were used interchangeably; one division of each group using the *A* test for immediate recall and the *B* test for delayed recall, while the order was reversed for the second division of each group. The equivalence of the two forms was tested by plotting percentile graphs for all scores made on each form. The reliability of the tests is shown by the following table:

	Form A	*Form B*
Upper quartile	83.7%	83.0%
Median	75.2	75.5
Lower quartile	68.0	67.5

Scores on the Achievement Tests: The combined scores of the two divisions in the Recitation First group, recorded in per cents (with a score of thirty-five representing one hundred per cent) were as follows:

	Immediate Recall	*Delayed Recall*	*Loss*
Upper quartile	87.0%	84.0%	3.0%
Median	78.3	76.0	2.3
Lower quartile	70.9	65.7	5.2

For the Laboratory First group, corresponding scores were as follows:

	Immediate Recall	*Delayed Recall*	*Loss*
Upper quartile	81.8%	78.6%	3.2%
Median	75.4	71.7	3.7
Lower quartile	68.0	66.0	2.0

Comparison of results: With the exception of the Delayed Recall scores for the Laboratory First group, the differences are all in favor of the Recitation First Group as shown in the following table:

Differences in Favor of Recitation First

	Immediate Recall	*Delayed Recall*
Upper quartile	5.2%	5.4%
Median	2.9	4.3
Lower quartile	2.9	−0.3

These differences appear, in the main, to be measurably greater than the differences in ability and in intelligence quotients as determined by the Terman Test.

Retention of factual knowledge, after four weeks, is greater for the Recitation First group at the upper quartile and median points but less at the lower quartile point as shown by the table:

Loss on Delayed Recall Test in Per Cent

	Recitation First	*Laboratory First*
Upper quartile	3.0%	3.2%
Median	2.3	3.7
Lower quartile	5.2	2.0

Validity of Tests: The validity of the two forms of test used to measure achievement in this investigation was checked by computing the coefficient of correlation according to the Pearson "Product-Moment" formula. The results are given below:

Recitation First Group	*Coefficient*
Terman Test and Immediate Recall	0.36
Terman Test and Delayed Recall	0.41
Immediate Recall and Delayed Recall	0.41
Laboratory First Group	
Terman Test and Immediate Recall	0.30
Terman Test and Delayed Recall	0.38
Immediate Recall and Delayed Recall	0.41
P. E. 0.05	

Discussion

Laboratory instruction is commonly regarded as essential to the course in high-school chemistry. Such instruction forms a part of the requirement of the College Entrance Examination Board. The committee on chemical education of the American Chemical Society, in its Report on a Standard Minimum High-School Course in Chemistry,[2] has stated as one of the objectives of such a course "To develop a careful correlation between recitation and experiment." The question of precedence of laboratory or recitation is therefore of importance.

Dr. Parr[1] has found "For the total population tested the 'recitation first' method is somewhat superior to the 'laboratory first' method of teaching." The results of the limited investigation reported in this paper appear to confirm this conclusion in the main; except that in the lower quartile the loss on "delayed recall" is greater for the Recitation First group than for the Laboratory First group.

It may be of interest to note that the general procedure in this school has been to use individual experimentation in the laboratory as a means of introducing new topics. For the Recitation First group, therefore, the order followed in this investigation was the reverse of the usual procedure. This group expressed a nearly unanimous preference for the Recitation First method on the grounds that previous knowledge of the procedure and results of an experiment helped them by giving a better understanding of the experiment and enabled them to attain more satisfactory results.

Acknowledgment is made of assistance rendered by Mr. George C. Anderson, of this school, who computed the scholastic averages of all pupils concerned and whose classes in chemistry participated in the investigation. Dr. O. E. Madison of the College of the City

[2] THIS JOURNAL, 1, 87-99 (May, 1924).

of Detroit furnished valuable material for the lesson outlines. Copies of the lesson sheets and tests are appended.

FRANK M. GREENLAW, *Chairman*
Rogers High School, Newport, R. I.

LESSON SHEETS AND TESTS

SUMMARY OF TOPICS: WATER

Occurrence

Water is the most abundant natural compound. It is indispensable to life, constituting approximately three-fourths of the weight of the animal body. It is contained in food as well as in drink and is necessary to the process of digestion and assimilation.

Water is a universal solvent, even dissolving minute quantities of substances ordinarily considered insoluble. For this reason, natural water is never pure from the chemical standpoint. Ground water (well water and spring water) often contains large amounts of dissolved mineral substances, some of which as iron, lithia, or sulfur may have mild physiological action. Spring waters often contain large amounts of dissolved carbon dioxide (carbonic acid gas). The presence of such substances, in moderate amounts, is not necessarily harmful.

Preparation

Pure water is obtained by boiling it and passing the steam into a tube or coil which is kept cool by being surrounded with running water. In this tube, the steam condenses to liquid again. This process is called distillation.

Non-volatile impurities are left behind in the boiler. Volatile impurities (substances easily vaporized) escape and are collected with the first portion of the distillate. If this portion (50–100 cc.) is rejected, the remainder of the distillate is pure water. Rain water collected after rain has fallen steadily for an hour or two is practically distilled water, and is the purest form of natural water.

Physical Properties

Water is a colorless, odorless liquid, tasteless when pure. It freezes at 0°C. and boils at 100°C. under standard atmospheric pressure. It is a universal solvent.

Water is a very stable substance. It may be partly decomposed by heating (steam) to a red heat; but in cooling, the constituents re-unite, giving out as much heat as was absorbed in the decomposition.

Chemical Properties

Water enters into chemical combination with many substances, and the compounds do not show the properties of water. Familiar compounds of this type are washing soda, alum, gypsum, and bluestone (blue vitriol). These are called hydrates. A hydrate is a substance which contains water in chemical combination with some other compound. It yields water when heated moderately, and the dry residue is said to be anhydrous (without water). Some hydrates, such as washing soda crystals (and to a less extent, bluestone), lose water of hydration on exposure to dry air, and crumble to a dry powder. Such substances are said to be efflorescent. If water is added sparingly to the dry residue, the water enters into chemical combination again, re-forming the hydrate. In the case of bluestone which has lost its water of hydration, the color is restored.

Water combines with oxides of metals to form substances called bases or hydroxides, of which slaked lime is an example. It also combines with oxides of non-metals to form substances called acids, of which carbonic acid is an example. Water, at room temperature, yields hydrogen on contact with active metals such as sodium and calcium.

Tests

A liquid may be identified as water if it freezes at 0°C. and boils at 100°C. under normal pressure. It may also be identified by reaction with anhydrous copper sulfate (derived from bluestone) which turns blue on addition of water.

Composition of Water by Volume

Hydrogen burned in air or oxygen forms water. If measured quantities of hydrogen and oxygen are put into a eudiometer tube over mercury and the mixture exploded by an electric spark, droplets

of water will be found in the tube. For exact combination with no residue of either hydrogen or oxygen, experiment shows that the proportions must be exactly two of hydrogen and one of oxygen. This is an illustration of Gay-Lussac's Law. The volumes of gases used and produced in chemical change can always be represented by the ratio of small whole numbers.

Water, to which a small amount of sulfuric acid has been added, is decomposed by passage of the electric current. Such decomposition by electricity is called electrolysis. (Pure water does not appreciably conduct electricity.) Oxygen collects over the anode; hydrogen, over the cathode. After the liquid has become saturated with dissolved gases, the volume of hydrogen obtained is exactly twice that of the oxygen.

Composition of Water by Weight

When hydrogen is passed over heated cupric oxide, the oxide is reduced to metallic copper and water is formed. The weight of water produced may be found by passing the water vapor and excess of hydrogen through a tube containing granular calcium chloride (which tends strongly to absorb water), and noting the increase in weight. The weight of oxygen used in forming this quantity of water is found by noting the loss in weight of the copper oxide. The weight of the hydrogen is obtained by difference. The most careful experiment shows that 1.008 grams of the hydrogen combine with exactly 8.00 grams of oxygen. This is an illustration of the Law of Definite Proportions by Weight.

Public Water Supplies

Suspended solid matter may be removed from water by simple filtration. Small amounts of dissolved mineral substances are usually not harmful. The water of lakes and streams used as the public supply for large communities may be and often is contaminated with microörganisms and sewage. This means the presence of organic matter in a state of colloidal suspension. Disease-producing bacteria may also be present. Such water is rendered potable (safe to drink) by filtration through large beds of sand and gravel or by a process called Mechanical Filtration. In this process, small amounts of a solution of aluminum sulfate or alum are added, and the water is thoroughly aërated. This coagulates the organic matter to visible, jelly-like flakes. The water then passes slowly through large basins in which most of the coagulated matter settles out. The remaining suspended material is removed by passing the water through relatively small filter beds of sand, gravel, and broken rock. As disease germs may pass through these filters, a small amount of chlorine (gas) is then added. This destroys the bacteria which may still be present and renders the water safe to drink. Such water is often said to be "purified." It is not pure from the chemical standpoint, which means the absence of all substances other than water.

Chlorination of public water supplies in recent years has largely done away with epidemics of typhoid fever.

TEST FORM A

Part I

Date *Name*

Directions: In each of the following questions several statements or values are given. Choose that one which, in your opinion, makes a true statement and indicate your choice by underlining it.

EXAMPLE: The liberation of oxygen, when potassium chlorate is strongly heated is an example of,
COMBINATION; DECOMPOSITION; DISPLACEMENT

1. *Water may be decomposed into hydrogen and oxygen by*
CATALYSIS; SYNTHESIS; ELECTROLYSIS; EMPHASIS
2. *Bluestone crystals, on exposure to dry air in the laboratory, often turn white on the edges. This is because they*
BECOME OXIDIZED; ABSORB WATER VAPOR FROM THE AIR; INCREASE IN WEIGHT; LOSE WATER OF HYDRATION
3. *Chemically pure water is obtained by*
FILTRATION; BOILING; DISTILLATION; CHLORINATION
4. *It is correct to say of crystalline hydrates that they all*
LOSE WEIGHT ON EXPOSURE TO AIR; GAIN IN WEIGHT WHEN HEATED; ABSORB WATER VAPOR FROM THE AIR; CONTAIN WATER IN A STATE OF CHEMICAL COMBINATION
5. *1.008 grams of hydrogen combine with 8.00 grams of oxygen to form 9.008 grams of water. This is an illustration of the*
LAW OF CONSERVATION OF MASS; LAW OF DEFINITE PROPORTIONS BY WEIGHT; LAW OF CHARLES; BOYLE'S LAW; AVOGADRO'S LAW
6. *Water, at room temperature, will yield hydrogen if acted upon by metallic*
IRON; ZINC; CALCIUM; TIN; COPPER

7. *10 cc. of hydrogen and 20 cc. of oxygen are put into a eudiometer tube and the mixture exploded by an electric spark. After the water vapor has condensed, the volume of the gas remaining in the tube is*
0 cc.; 5 cc.; 10 cc.; 15 cc.; 20 cc.
8. *Small amounts of chlorine are usually added to water at filtration plants to*
PRECIPITATE DISSOLVED SOLIDS; SOFTEN THE WATER; DESTROY DISEASE-PRODUCING BACTERIA; IMPROVE THE TASTE OF THE WATER
9. *10 grams of gypsum (calcium sulfate hydrate) is heated at first moderately and then strongly in air until there is no further loss in weight. The anhydrous residue weighs 7.91 grams. The per cent of water of hydration is*
100%; 79.1%; 20.9%; 15.8%; 7.91%
10. *A transparent liquid may be shown to be water if it*
DISSOLVES RESIN; YIELDS HYDROGEN ON THE ADDITION OF ZINC; IS COLORLESS AND WEIGHS 1.5 GRAMS PER CC.; FREEZES AT 0°C. AND BOILS AT 100°C.
11. *Alum is added to water at city filtration plants to*
KILL BACTERIA; SOFTEN THE WATER; COAGULATE THE ORGANIC MATTER; MAKE THE WATER PURE
12. *A crystalline substance which crumbles to powder and loses weight on exposure to air is said to be*
EFFLORESCENT; DELIQUESCENT; ANHYDROUS; STABLE; A DEHYDRATING AGENT
13. *Water may be freed from non-volatile impurities by*
ELECTROLYSIS; BOILING; FILTRATION; DISTILLATION; STANDING FOR A LONG TIME
14. *The natural form of water which is most nearly pure water is*
LAKE WATER; RIVER WATER; WELL WATER; SPRING WATER; RAIN WATER
15. *A certain water supply is of such a degree of hardness that one ounce of fresh washing soda crystals is required to soften one pailful of water. If the washing soda has become powdery from exposure to air the quantity needed will be*
MORE THAN ONE OUNCE; LESS THAN ONE OUNCE; EXACTLY ONE OUNCE.

Part II

Directions: The following single statements are either true or false. Indicate your decision by underscoring either the word *TRUE* or the word *FALSE*.
EXAMPLE: Oxygen is necessary to life. TRUE. FALSE.

1.	*Nitrogen is a constituent of water.*	TRUE	FALSE
2.	*Rain water is purer than well water.*	TRUE	FALSE
3.	*Sea water leaves no residue on evaporation.*	TRUE	FALSE
4.	*Water has a higher temperature when boiling vigorously than when it boils gently.*	TRUE	FALSE
5.	*Steam is water in a gaseous state.*	TRUE	FALSE
6.	*Ice and water do not have the same chemical composition.*	TRUE	FALSE
7.	*The water of a shallow farm yard well is more frequently polluted than spring water.*	TRUE	FALSE
8.	*Natural waters contain a small amount of dissolved oxygen.*	TRUE	FALSE
9.	*The flat taste of distilled water may be removed by shaking it vigorously in a partially filled bottle.*	TRUE	FALSE
10.	*If a water supply is probably contaminated, small quantities may best be rendered safe to drink by boiling the water.*	TRUE	FALSE

Part III

Directions: Each of the following questions contains several statements: All of these statements may be true, or one of them may be false. If you find a false statement in any question, underline it. Otherwise write *TRUE* in the space immediately following the question.
EXAMPLE: Oxygen is a gas; it is slightly denser than air; and can easily be liquefied. .....
1. *All living organisms contain water; it is found in the air, on the surface, and below the surface of the earth; it is a chemical compound formed by the union of two gases, it dissolves nearly all substances to a greater or less extent.* .....
2. *Rain water is the purest natural form of water: water for drinking purposes may be obtained from sea-water by distillation; chemically pure water leaves no residue on evaporation; filtered sea-water may be used in the boilers of ocean steamships.* .....
3. *The conversion of water into ice or steam is a physical change; water is the standard of reference in determining the density of liquids and solids; water enters into chemical combination with many other compounds; all substances containing combined water are moist.* .....
4. *Water is always formed during the combustion of compounds containing hydrogen: two-thirds of the*

weight of water is made up of hydrogen; steam may be decomposed by passing it over white hot iron or coke; a large amount of energy must be expended in decomposing water. .....

5. *Public water supplies are filtered to remove organic matter, including bacteria; ground water from deep-driven wells is usually safe to drink; the sparkling taste of spring waters is due to the presence of dissolved gases; boiled water tastes flat because volatile substances have been driven off by heating.* .....

Underline method used: LABORATORY RECITATION

Underline science subjects previously studied for one year or more: GENERAL SCIENCE; BIOLOGY; PHYSICAL GEOGRAPHY; PHYSICS; CHEMISTRY

TEST FORM B

Part I

Date *Name*

Directions: In each of the following questions several statements or values are given. Choose that one which, in your opinion, makes a true statement and indicate your choice by underlining it.

EXAMPLE: The liberation of oxygen, when potassium chlorate is strongly heated, is an example of
COMBINATION; DECOMPOSITION; DISPLACEMENT

1. *The gases obtained by the electrolysis of water (to which a small amount of sulfuric acid has been added) are*
NITROGEN AND HYDROGEN; HYDROGEN AND OXYGEN; OXYGEN AND NITROGEN; OXYGEN, NITROGEN, AND HYDROGEN
2. *One pound of washing soda crystals are left exposed to the air and crumble to a dry powder. After this exposure they weigh*
EXACTLY ONE POUND; MORE THAN ONE POUND; LESS THAN ONE POUND
3. *Natural water may be rendered pure by*
BOILING; FILTERING; DISTILLING; SETTLING
4. *It is correct to say that*
ALL HYDRATES ARE MOIST; ALL HYDRATES CONTAIN COMBINED WATER; ALL HYDRATES ARE HYDROXIDES; ALL HYDROXIDES ARE HYDRATES
5. *When hydrogen combines directly with oxygen, the proportions by volume according to which they unite are two of hydrogen to one of oxygen. This is an illustration of*
BOYLE'S LAW; LAW OF MULTIPLE PROPORTIONS; LAW OF CONSERVATION OF MASS; GAY-LUSSAC'S LAW; AVOGADRO'S LAW
6. *The composition of water by weight can be determined by weighing the substances used and produced in the following reaction*
HEATING POTASSIUM CHLORATE; ACTION OF ZINC ON DILUTE SULFURIC ACID; ACTION OF HYDROGEN ON HEATED CUPRIC OXIDE; HEATING GYPSUM
7. *Public water supplies for large cities are rendered safe to drink by*
FILTRATION AND CHLORINATION; DISTILLATION; BOILING
8. *25 cc. of hydrogen and 20 cc. of oxygen are put into a eudiometer tube and the mixture exploded by an electric spark. After the water vapor has condensed, the volume of gas remaining in the tube is*
5 cc.; 7.5 cc.; 10 cc.; 12.5 cc.; 15 cc.
9. *An example of an efflorescent substance is*
SALT; BAKING SODA; CALCIUM CHLORIDE; WASHING SODA; SUGAR
10. *10 grams of crystallized barium chloride (barium chloride hydrate) is heated at first moderately and then strongly in air until there is no further loss in weight. The anhydrous residue weighs 8.53 grams. The per cent of water of hydration is*
100%; 85.3%; 50%; 14.7%; 8.53%; 1.47%
11. *A pinch of anhydrous cupric sulfate is placed in a porcelain dish and a few drops of a colorless liquid are added. The liquid is shown to be water if*
BUBBLES OF A GAS ARE GIVEN OFF; THERE IS NO CHANGE IN APPEARANCE; THE POWDER TURNS BLUE
12. *Untreated water is not considered safe to drink if chemical tests show the presence of a considerable quantity of*
LITHIA; IRON; CHLORIDES; BICARBONATES; CARBON DIOXIDE; GAS
13. *When water is distilled it is freed from volatile impurities by*
COOLING THE DISTILLATE; FILTERING THE DISTILLATE; REJECTING THE FIRST PORTION OF THE DISTILLATE; ADDING ALUM; ADDING CHLORINE
14. *The proportions by weight according to which oxygen and hydrogen unite to form water are approximately*
ONE OF HYDROGEN TO TWO OF OXYGEN; TWO OF HYDROGEN TO ONE OF OXYGEN; EIGHT OF HYDROGEN TO ONE OF OXYGEN; ONE OF HYDROGEN TO EIGHT OF OXYGEN

15. *Water vapor can be removed from air by passing the air slowly through a tube loosely filled with* WASHING SODA; BAKING SODA; MARBLE CHIPS; CALCIUM CHLORIDE; SAND

Part II

Directions: The following single statements are either true or false. Indicate your decision by underlining either the word TRUE or the word FALSE.

EXAMPLE: Oxygen is necessary to life. TRUE. FALSE.

1.	*Water is a chemical element.*	TRUE	FALSE
2.	*Water is a universal solvent.*	TRUE	FALSE
3.	*Ocean water and fresh water freeze at the same temperature.*	TRUE	FALSE
4.	*The temperature at which water boils depends on the size of the flame used in heating it.*	TRUE	FALSE
5.	*Water which is clear, cold, and odorless is always safe to drink.*	TRUE	FALSE
6.	*Distilled water is condensed steam or water-vapor.*	TRUE	FALSE
7.	*Well water usually contains more dissolved mineral matter than does lake-water.*	TRUE	FALSE
8.	*Dissolved substances may be removed from water by simple filtration.*	TRUE	FALSE
9.	*The flat taste of distilled water is due to the absence of dissolved gases.*	TRUE	FALSE
10.	*Filtration and chlorination are used to purify water in large quantities for cities.*	TRUE	FALSE

Part III

Directions: Each of the following questions contains several statements. All of these statements may be true, or one of them may be false. If you find a false statement in any question, underline it. Otherwise, write TRUE in the space immediately following the question.

EXAMPLE: Gold is heavy; has a yellow color; and is a soft metal. TRUE.

1. *Water is indispensable to life; it is necessary to digestion and the assimilation of food; it is the most abundant natural compound; it is not readily decomposed by heating.* .....
2. *Boiling destroys bacteria and microörganisms in water; household filters of the simple strainer type are of doubtful value; water may be safe to drink even if it is not chemically pure; pure water is obtained by the distillation of natural water.* .....
3. *Water is pure if it boils at 100°C. (under standard pressure) and freezes at 0°C.; it is a universal solvent; one cubic centimeter of water weighs one gram; spring water contains no dissolved substances.* .....
4. *Water is a very stable compound; in its formation by the combination of hydrogen and oxygen, a large amount of heat is given out; water to which a small amount of acid has been added may be decomposed by an electric current, pure water does not conduct electricity appreciably.* .....
5. *In the filtration of a public water supply, aluminum sulfate is added to coagulate the organic matter; the coagulated material is removed by settling and subsequent filtration; small amounts of chlorine are then added to give the filtered water a better taste.* .....

Underline method used: LABORATORY; RECITATION.

Underline science subjects previously studied for one year or more: GENERAL SCIENCE; PHYSICAL GEOGRAPHY; PHYSICS; CHEMISTRY.

THE TRAINING OF TEACHERS OF CHEMISTRY IN SECONDARY SCHOOLS IN SOME FOREIGN COUNTRIES*,[1]

In addition to the project indicated in the title of this report, the committee has been engaged, during the year, in the study of another problem, viz., the training received by over 200 teachers now in service in American high schools, and possible means for the improvement in the type of training of chemistry teachers in the future. This study was made in coöperation with the committee on "Professional Spirit among Chemistry Teachers," and is presented as a part of the report of that committee.[2]

Requests were sent to eight foreign countries asking for information concerning the

* Report of the committee on "Preparation of High-School Chemistry Teachers" submitted to the Senate of Chemical Education at Atlanta, Ga., April, 1930.

[1] See THIS JOURNAL, **5**, 743–7 (June, 1928); **6**, 1156–7 (June, 1929).

[2] *Ibid.*, **7**, 1366–70 (June, 1930).

requirements for chemistry teachers in the secondary schools of these countries. Replies have been received from England, Scotland, Canada, Australia, France, and Germany.

In the following discussion it is understood that certificates are granted for teaching "mathematics," "science," and the like. No certificate is granted for chemistry only. The certificates dealing with "science" are the ones which we are considering.

The material received from France gives no information as to definite requirements for teachers. As it deals largely with the syllabi for chemistry courses in the secondary schools and colleges, the information has been omitted from this report.

Throughout Canada, England, Scotland, and Australia, a college degree or its equivalent is generally required. Scotland and many states in Australia and Canada specify that some pedagogy either in a normal school or a college be completed before the granting of the certificate. Scotland requires that all applicants have had professional training including *at least* general school methods and methods in the special subject for which the certificate is granted as well as practice teaching in that subject. In Canada, normal school training is a prerequisite. There is a movement on foot now, however, to certify students to teach in secondary schools upon graduation from a university, provided certain specified subjects have been satisfactorily completed. The University of Toronto has already made this change. Each province in Canada has its own special requirements much the same as the states of the United States do. There is a detailed table showing these standards on page sixty-four of the "Annual Survey of Education in Canada" for 1927.[3] Australia as a country has set no definite standards; however, many of the requirements made by various sections of the country are quite uniform. Although Brisbane makes no special pedagogical requirements, Sydney prefers teachers with at least one year's experience. Melbourne, Perth, Hobart, and Adelaide specify definite work. Melbourne goes so far as to say that the teachers should have a diploma of education from the University of Melbourne. They recommend that this work be done during one year of graduate study. Hobart, Adelaide, and Perth state that the teacher take a given course in the teachers' college before entering the university. There he takes from two to four years of chemistry but this follows the teachers' college course.

In Scotland and England, students having obtained a degree and first- or second-class honors may be granted a certificate to teach the subject in which honors are won. It is possible to receive these honors after graduation.

England seems to be favoring the highly specialized teacher, that is, those trained to teach just chemistry or physics or possibly both. In "Teaching of Science in Secondary Schools for Boys in England" (page 11), we find that "of the 210 teachers in boy's schools about 36% teach physics *or* chemistry only, another 15% teach physics *and* chemistry and only 30% combine both of these subjects with mathematics." This condition may be partially accounted for by the fact that teachers are unwilling to teach a science subject which has not formed part of their university course. This encourages boys to study physics and chemistry since teachers of biology are difficult to get. There is no evidence from the material at hand that any of the other countries named are favoring such specialization.

The requirements in Germany are very comprehensive, viz.:

1. The candidate must study at least four years at a technical college or university, three years of which shall be devoted to the major field. In Bavaria, for example, this major field, embraces chemistry, biology, geology, mineralogy, and geography. Physics and mathematics constitute another science major field. The requirements as to the major field are not quite as closely restricted in the German Republic at large. At the

[3] Published by F. A. Acland, Ottawa—price 50 cents.

end of the university course the candidate must pass comprehensive examinations consisting of:

(1) A written examination in chemistry, biology, mineral science, and geography, requiring three to four hours for each field.
(2) An oral examination of forty to sixty minutes on inorganic and organic chemistry with consideration of chemical technology and modern chemical theories.
(3) A practical examination to show familiarity with operations in analytical chemistry. One day is devoted to qualitative analysis and two days to quantitative analysis. Similar practical examinations are required in the other sciences studied.
(4) A written treatise of at least 16 printed pages on a theme selected from one of the three fields of science studied, which must give evidence of a broad scientific education. (This treatise, however, is disregarded in the final grading of the candidate.)

2. The candidate, after having successfully completed the university examinations, is known as "Studienassesor," and must now devote a school year to practice teaching and study of pedagogical methods in an approved secondary school (Realgymnasium, or Realschule), under the direction of a "Seminarlehrer," a regular teacher of the school appointed to this work by the Minister of Education. Upon completion of the year's work in practice teaching ("Seminarjahr"), the "Studienassesor" must pass examinations consisting of:

(1) Practice teaching of one hour to show skill in experimentation before the class, in sketching apparatus upon the blackboard, and in supervision of the individual experiments of the pupils.
(2) An oral examination covering pedagogy including methods used in science instruction, and the fundamentals of philosophy and psychology. The candidate is expected to have a thorough knowledge of the historical development of these fields including the history of the special sciences which he is to teach. The "Seminarlehrer" is a member of the examining board.
(3) A written treatise on methods of teaching, independently worked out, must be submitted.

The certificate granted upon successful completion of the university course and seminar year of practice teaching is roughly equivalent to the degree of Master of Science conferred by higher institutions in the United States and Great Britain. A considerable number of the teachers hold the degree of Doctor of Philosophy. After the "Seminarjahr," the candidate usually has a probationary year ("Probejahr") in which he teaches about 24 hours weekly for little or no pay. Priority in appointment to teaching positions is based upon the relative standing of candidates in the examinations and the work of the "Probejahr." (Not unlike the Civil Service in the United States.) The State, through the Minister of Education, is the supreme authority in making appointments.

In comparing the German requirements with those in our own country, one is impressed with the very high degree of specialization and thoroughness in the training of the teachers in Germany. Another interesting contrast is the fact that the instruction in chemistry and presumably all other secondary school subjects is almost, if not entirely, carried on by men teachers. The standards set for the science teachers of Germany may seem perhaps beyond realization in this country because of racial and social differences. An approach to these standards, however, throughout the United States, would raise the teaching of chemistry and the other sciences to a much higher degree of efficiency than that which exists at the present time.

References

1. "Teaching of Science in Secondary Schools for Boys in England."
2. "Prospectus of Edinburgh Provincial Training Center."
3. "Statutory Rules and Orders," **1924,** No. 791. Scotland, Circular 62.
4. "Scottish Educational Department," Circular 20, 1929.
5. "Annual Survey of Education in Canada," 1927.
6. Prüfungsordnung für das hohere Lehramt in Bavaren.
7. Nr. 27 Prüfungsvorschrift für das Lehramt an Mittelschulen.
8. "The Training of Science Teachers, Here and Abroad," N. Henry Black, *Sch. Sci. Math.*, **30,** 153 (1930).
9. Personal letters from various Educational Departments.

A. J. CURRIER, *Chairman*
HENRIETTA HAYDEN
LOUIS A. MATTERN

PROFESSIONAL SPIRIT AMONG HIGH-SCHOOL TEACHERS OF CHEMISTRY. III*

The work of this committee has had two objectives: (1) to correspond with the secretaries of the Local Sections of the American Chemical Society in regard to the activity of their respective sections in matters related to chemical education; (2) to obtain direct information from a list of high-school chemistry teachers selected from different parts of the United States in regard to additional teaching subjects, extra-curricular matters, training in subject matter, other educational courses, and requirements for appointment. On the second objective, this committee had the help of Dr. A. J. Currier, of the chemical department of Pennsylvania State College, who is chairman of the committee on The Training of High-School Chemistry Teachers, in preparing the information sheets sent to the above list of teachers and in making its report on the information thus received. The committee also hereby acknowledges the valuable services of Dr. Frances Moon Butts, head teacher of the business department of the McKinley High School, and of her student assistant, Miss Rachel Holst, in compiling statistics from the information sheets.

Activities of Local Sections of the American Chemical Society in Relation to Chemical Education

In accordance with the belief of this committee that a large amount of good could be accomplished if each Local Section would, according to its wisdom, devote attention to some phase of chemical education, the committee conducted a correspondence to that end with these Sections. Not that such attention would have only formal chemical education as its object in which teachers alone would be interested, but informal chemical education as well in which both the public and the teacher would be interested.

An invitation to chemistry teachers to attend a meeting of the former type or to a regular meeting addressed by an outstanding personality in the field of chemistry would tend to enliven and increase interest in the teaching of chemistry. An invitation to the people at large to attend a meeting of the second type would encourage the public to become more interested in chemistry in relation to the welfare of individual,

---

* Third report of the committee of the Division of Chemical Education of the A. C. S. on Professional Spirit among High-School Teachers. For the other two reports see THIS JOURNAL, **5,** 747–9 (June, 1928); **6,** 1157–9 (June, 1929).

community, and national life, and to its importance as a study in educational institutions.

In addition to the technical papers usually given at the Local Section meetings with great profit to the chemists, there is the large opportunity of spreading the gospel of chemistry to a democracy whose basic advancement depends on chemistry. Who can ever forget the intelligent and impassioned plea of Francis P. Garvan, our great benefactor in chemical education, at the Yale meeting for a great interest on the part of professional chemists in chemistry as related to humanity?

Replies from secretaries of Local Sections to correspondence referred to show clearly a growing interest in both formal and informal chemical education. One section writes, "Secondary school professors of chemistry are most essential in the chemical scheme of things, as it is to them that we look for our most fundamental raw material personnel. Most decidedly interested in your work and desire to forward it in every way." Others write about "Ladies Night" at which interesting talks and samples are presented by various manufacturers, the placement of current literature in high-school libraries, radio lectures, chemical expositions, and program arranged for the next meeting of the State Teachers' Association. A large number of Local Sections make some one of the following arrangements:

1. For a section on chemical education on the program of their Divisional Meeting.
2. For chemical lectures of a popular nature.
3. For offering a prize to the high-school student who passes the best examination in chemistry.
4. For inviting teachers who are not members of the section to be present when there is an especially good lecture which would provide instruction and inspiration.
5. A large local section has one main event after which there are short group meetings, one of which is for chemistry teachers.

The committee desires to express its hearty appreciation to Local Sections for their courteous and helpful replies and to congratulate the cause of chemical education in the different manifestations of interest.

Report on the Information Received from 218 High-School Teachers of Chemistry

This list includes teachers from different parts of the United States selected by members of this Committee from schools with enrolments of over 500 and from a very few with enrolments under that number.

The total enrolment of the schools represented in this report numbers 280,087. Of this number 147,281 are boys and 132,806 are girls. The percentage of the total enrolment taking chemistry is 10.67. Of the boys, 13.66% take chemistry, and of the girls, 7.7%. It is noted that in *Bulletin* 35671, U. S. Bureau of Education for 1928, 7.3% of an enrolment of 3144, 645 high-school students took chemistry.

Of the 218 schools 27 indicate more than the usual two semesters of general chemistry and 12 offer different types of courses for the two semesters. The very strong tendency in these general chemistry courses is to give 3 periods of recitation and 2 double periods for laboratory work per week.

Of the 218 teachers reporting there are 72 teaching other subjects than chemistry. The following shows the number of other subjects taught by these 72: physics 29, general science 26, biology 14, algebra 10, mathematics and physiography 5 each, plane geometry 4, physical education and occupations 3 each, botany, solid geometry and trigonometry 2 each, astronomy, business law, English, French, geography, geology, and U. S. history, 1 each. It is perhaps safe to say that in the smaller high school this condition exists to a very much greater extent and doubtless necessarily so.

The rapid developments of chemistry and its relation to all phases of life make it important that teachers of this subject be well trained and up to date. Too many teaching subjects make it more difficult to attain that end.

In addition to the load of teaching other subjects than chemistry, high-school teachers of chemistry have a grievous burden as seen in the following:

Out of the 218 teachers who reported practically all have other assignments in addition to teaching. The following table gives the assignments and the time consumed in carrying them out: 50 have a homeroom section or advisory and attendance checking period for at least 5 periods a week; 9 have the same duty for less than 5 periods a week; 33 have charge of a study hall for at least 5 periods a week; 22 have hall duty, lunchroom supervision, etc., at least 5 periods a week and 19 are called for the same duty less than 5 periods a week; 18 have charge of a study hall less than 5 periods a week; 13 have administrative duties other than in their own departments; 6 have work as heads of departments; 5 act as registrars; 4 have dormitory assignments part of the time; 2 are required to attend faculty meetings once a week; and 2 serve on credit commissions to determine the eligibility and ranking of students; 60 are supervisors and sponsors in these capacities; athletics 20, student guidance 9, chemistry club 8, school newspaper 7, dramatics 4, student council 2, debating and oratory 2, yearbooks 2, literary society 2, radio club 1, High Y 1, and motion picture work 1.

In the above listing the concentration of assignments is as follows: 80 have only one assignment, 66 have two outside assignments, 30 have three assignments, 8 have four and 3 have five assignments. For example, one of those with four assignments has an opening period, a study hall each day in addition to being treasurer of the athletic association and guardian of the senior class. Another has a study hall, a homeroom each day, is also director of athletics, and the basket ball coach. It is plain that there are too many outside activities included with the teaching responsibilities. 20 have no extra assignments. Why should not the large number of schools follow the small number that do not have these extra assignments?

The foregoing indicates a situation that should be remedied in the interest of the time needed by the teacher to prepare for demonstrations, student laboratory work, improvement of experiments, and keeping in touch with laboratory records so as to develop in the students a laboratory consciousness of a scientific nature.

Such a training might not score so highly in certain types of examinations as compared with the high-pressure methods of memorized information which is better rewarded in the grading of certain types of examination papers, but such training is very likely to be important in the student's further development. Individual laboratory work is doubtless slower from the standpoint of work covered, and also burdensome to handle properly, but the value of this type of training and the reality of things studied through personal experiences are well worthwhile.

Education of Teachers

Of the 217 teachers reporting on the question bearing on their education 111 received the B.A. degree; 99 the B.S.; 6 both B.A. and B.S.; 29 the Master's; 9 the Ph.D.; and only one whose training did not go beyond a high school. In addition to these degrees 82 have done additional work after receiving the B.A. or B.S. degree, and 50 have done additional work after receiving the Master's degree.

One hundred and fourteen of the 217 teachers questioned have taken a course in history of education, 103 have taken educational psychology, 68 educational administration, 67 psychology, 62 methods of teaching, 54 methods of teaching chemistry, 41 principles of secondary education, 31 philosophy, 21 educational philosophy, 19 methods of science, 18 practice teaching, 18 teaching physics, 15 sociology, 8 teaching physics and chemistry, 8 high-school supervision, 8 pedagogy, 5 teaching mathematics, 5 mental development, 4 each of ethics, logic, and vocational guidance; 43 had had a scattering of educational courses and *44 had had none at all.*

The number of courses in education taken by each individual is shown in the following: 55 have taken only one course, 22 have two courses to their credit, 17 have three, 33 have four, 28 have five, 52 have six, 12 have seven, 7 have eight, 1 has nine, 1 has ten, 2 have eleven, and 3 of the 217 teachers have taken twelve educational courses.

Educational Courses Advised by Teachers

In meeting the present situation with respect to subject matter and other professional courses the opinion of the 217 teachers was sought. Of the teachers replying, the following educational courses were deemed necessary: 112 advised methods of chemistry teaching; 98 psychology; 59 tests and measures; 40 practice teaching; 28 history of education; 24 philosophy; 21 principles of education; 18 school administration; 6 history of science; 4 curriculum; 5 secondary education. Other subjects suggested were: character training, mental hygiene, ethics and logic, visual education, economics, vocational guidance. A few could see no value in education courses to the teacher of chemistry.

Chemistry Courses Advised by Teachers

Chemistry courses most needed for preparation in teaching high-school chemistry beyond general chemistry in the judgment of the teachers reporting in order of preference are: organic—advised by 182, qualitative—160, quantitative—141, physical—112, inorganic—86, industrial—47, analysis—17, historical—17, household—25, physiological—20, biological—13, colloidal—13, mathematical—10, geological—9, electro—8. Others suggested are: astronomy, agricultural, atomic, catalytic, cultural chemistry courses, glass blowing, gravimetric, petroleum, spectro analysis, synthetic chemistry and volumetric analysis. Among the subjects recommended are mineralogy—12, astronomy and library science.

Regulations Governing Appointments of Chemistry Teachers

It is noted that of the chemistry teachers thus reporting, 4 advise 2 chemistry courses; 13—3; 34—4; 42—5; 44—6; 17—7; 36—8; and 5—9.

Replies from 217 teachers listed in this survey, to the question, "State the principal regulations governing the appointment of chemistry teachers in your school," 20 did not answer, 18 require a degree and 2 years experience, 6 a B.S. or B.A. degree, 4 a degree and 3 years experience, 4 appointment through principal, superintendent, and school board, 4 an A.M. degree or equivalent, competitive examination and 3 years experience, 4 require written examination, class test, oral test, placed on a list subject to call due to vacancy—done by board of education, 3 appointment on a competitive examination taken from a rated list, 3 a college degree with a major in chemistry, 2 examinations and probation, 2 examination and approval by the Principal, and the rest of the replies were so widely variant that space will not permit of their classification. The chairman of the committee has on file all of the replies to this question.

The pressure of educational courses on high-school teachers of chemistry as suggested by the foregoing and the wide variety of subjects indicated raises four questions: 1. Is the emphasis placed on professional courses or on subject matter? 2. Since it is apparently practically impossible to take all of the more prominent professional courses mentioned in the above list, which ones should be taken? 3. Is it possible to take the bachelor's degree in chemistry with its related major and minor groups and background subjects and at the same time meet the pressure of professional courses? 4. May not the solution be found in requiring a master's degree in order to make provision for adequate subject matter and other professional courses?

Conclusions

Extra teaching subjects, although apparently advisable from an administrative point of view, are not to the best interest of teaching chemistry.

Extra curricular activities *endanger* the educational efficiency of teaching chemistry in high schools by consuming time and diverting attention from the basic importance of demonstrations and student laboratory work, both of which require much time.

In the teaching of chemistry in high schools a broad thorough knowledge of subject matter is a prime requisite. But a reasonable number of suitable professional educational courses is considered advisable, in order that chemistry may be taught in a most effective manner from the standpoint of content of subject matter and in harmony with the general educational objectives which are especially desirable during the impressionable ages of high-school students.

The standards for appointments of high-school chemistry teachers set up by educational authorities should be reasonably uniform, containing a balanced knowledge of chemistry subject matter and professional educational courses.

Consequently the requirement of a master's degree is indicated as a solution of the difficulty in finding time for the proper preparation of the high-school chemistry teacher.

Respectfully submitted,
LOUIS W. MATTERN, *Chairman*

Committee:

LOUIS W. MATTERN, McKinley High School, Washington, D. C., *Chairman.*
JOHN T. FULTON, Oregon State Agricultural College, Corvallis, Oregon.
HAL WALTERS MOSELEY, Tulane University, New Orleans, Louisiana.
M. CANNON SNEED, University of Minnesota, Minneapolis, Minnesota.
CHARLES H. STONE, English High School, Boston, Massachusetts.

Synthetic Leather. There is now being manufactured in Europe a product known as synthetic or regenerated leather which is arousing considerable interest. Synthetic leather is made from leather scrap which apparently has been finely shredded and then recombined with a binding agent to produce a homogeneous product simulating some of the physical properties of genuine leather. It is not like "artificial leather" which is manufactured by coating a cloth base with pyroxylin and which resembles leather only in surface appearance.

Synthetic leather has the appearance of leather; the cutting value is good, but the tensile strength is below that of genuine leather.

The industry, which is still in its infancy, started in Europe about two years ago, under the name of S. A. Lavorazioni Pellami (SALP) of Turin and Milan. The SALP is affiliated with Snia Viscosa. Recently, a subsidiary of the Italian company was formed and is now in operation in France. Interest has been shown in Germany as well, where factories are operating under other patents but with less success than in Italy and France, due to high production costs. An American subsidiary of the SALP is understood to have invested several million dollars in a new plant for producing synthetic leather.

Up to the present time a number of kinds of synthetic leather have been produced abroad. Hat sweat-band leather and case leather for luggage are being made, although the latter does not appear to have had as much commercial success as was at first anticipated. Attempts to use synthetic leather in the manufacture of shoes do not appear as yet to have been successful.—*Ind. Bull., A. D. Little, Inc.*

PRELIMINARY ANNOUNCEMENT—CINCINNATI MEETING, SEPTEMBER 8–12, 1930

The eightieth meeting of the American Chemical Society will be held in Cincinnati, Ohio, during the week of September 8th.

Program: The Division of Chemical Education is planning an attractive program which will include a symposium on "The Qualifications of Chemistry Teachers" and several sessions for the discussion of miscellaneous papers. It is probable that these program sessions will be confined to Tuesday, Wednesday, and Thursday.

Business Meetings: The Senate will meet Wednesday to receive committee reports while the Division will hold a brief business meeting Thursday, the chief item of business being the election of officers.

High-School Teachers: The Division is anxious to establish contacts with every teacher of chemistry. On Wednesday, September 10th, through the courtesy of Mr. Wm. W. Buffum, the Division and Senate will be hosts at luncheon to all high-school teachers in the Cincinnati area. These guests will also attend the symposium.

Special Student Rates: The Society has voted to allow any regularly matriculated student, majoring in chemistry in any college or university, to register for the entire meeting for $3.00, instead of the $8.00, which is charged non-member chemists. Sleeping accommodations at a nominal rate may also be secured by addressing the Local Secretary, Father E. J. Morgan, St. Xavier College, Cincinnati, provided arrangements are made in advance of August 16th.

Exhibits: Manufacturers of chemical apparatus and products, high-school and college laboratories, and other agencies which are interested in chemical education, are invited to send exhibits for the Cincinnati Meeting. Free exhibition space will be reserved upon request to the Local Secretary, but each exhibitor must assume all costs of transportation and packing as well as responsibility for breakage and loss.

A prize of $10.00 is offered by the Division for the best exhibit prepared by a high-school chemistry class.

Papers for the Program: Notice to Authors

By vote of the Council of the A. C. S., papers by American chemists not members of the A. C. S. shall not appear on the program unless they be joint papers with Society members, and no papers may be presented at a meeting unless the title has been printed on the final program.

Titles for papers designed to be read before the Division of Chemical Education should be sent as early as possible to the Secretary of the Division. The rapidly increasing number of papers makes the exclusion of some inevitable. Papers for the symposium on The Qualifications of Chemistry Teachers will be by invitation.

It may be of interest to experienced teachers that requests have been received by the Secretary for papers on the topics shown in the following list.[1]

1. Duplication in High-School and College Courses.
2. A More Intensive Study of a Limited Field in High-School Chemistry.
3. How Best to Use the Conceptions of Sub-Atomic Structure in Teaching High-School Chemistry.
4. What Products and Processes of Chemical Industry Should Be Included in Introductory Chemistry?
5. Recording Laboratory Notes.
6. Retaining Good Teachers of Chemistry in Competition with Industry.
7. In Training Chemists Should Regular Courses in the Mathematics Department Be Supplemented by Special Courses Offered by the Departments of Chemistry and Physics?

[1] As a by-product of a recent letter-ballot, the topics listed have been suggested by members of the Senate of Chemical Education as suitable for early discussion. A much longer list may be had by addressing the *Secretary*.

8. The Neglect of Cultural Subjects in Scientific Courses of Study.
9. Teaching Theory and Chemistry Calculations in High School.
10. How Much Modern Language Should Be Required for College Chemistry?
11. A Year of General Chemistry in College vs. the One-Semester Plan.
12. The Place of History in First-Year College Chemistry.
13. The Place of Research in Undergraduate Chemistry Courses.
14. Desirability and Use of the So-Called Comprehensive Examination in College Courses Leading to the Bachelor's Degree.
15. Distinctly Different Courses for High-School and College Chemistry.
16. Is There an Implied Responsibility on the Part of the Director of the Chemistry Course to Get the Young Graduate His First Job?

It is important to note that one copy of the *completed* paper together with two copies of an abstract must reach the Secretary not later than August 1st. Manuscripts received after this date will be held over, with the author's consent, for the Indianapolis Meeting in April, 1931.

Papers read before the Division become the property of the Society, and, if acceptable for publication, will appear later in THIS JOURNAL.

Since the time available for each paper will be strictly limited, authors are earnestly requested to coöperate as follows:

1. Condense the material so that it may be presented in 5–8 minutes, leaving time for adequate critical discussion which should be one of the chief functions of our program meetings. In general only fifteen minutes, including discussion, will be allotted any one paper.
2. Organize significant features on slides, films, or in mimeographed form for distribution.
3. Do not send in a title unless you expect to be present to read your paper.

R. A. BAKER, *Secretary*,
Syracuse University, Syracuse, New York

Find Natural Gas Containing Seven Per Cent Helium. The accidental finding of a source of natural gas in southeastern Colorado said to contain seven per cent of helium, the richest helium discovery ever made, was reported recently by F. F. Hintze, of the University of Utah, before the American Institute of Mining and Metallurgical Engineers.

Helium is usually found in natural gas only to the extent of one or two per cent. "An open flow of 3,000,000 cubic feet per day was the estimated volume of the gas flow, and the helium content is said to be 210,000 cubic feet per day," elaborated Mr. Hintze. This does not mean that the well would yield 3,000,000 cubic feet of gas and 210,000 cubic feet of helium per day continuously. Its daily production would doubtless be less than a quarter of its open flow.

This discovery helps to clinch the hold of the United States on the world monopoly of the non-inflammable lifting gas for airships. The present price of helium is about $20 the thousand cubic feet, much higher than that of hydrogen, its inflammable competitor.

The discovery was made during oil-drilling operations just south of the little town of Thatcher. The gas comes from a depth of about 900 feet.

The American Helium Company has located a small refining plant at Thatcher. The only other plants in the world for extracting helium from natural gas are at Dexter, Kansas, and Amarillo, Texas. The one at Dexter is another small plant of the private company while the large refinery the U. S. government established during the World War is located at Amarillo.—*Science Service*

The Chemistry Student

SOME ELEMENTARY PRINCIPLES OF X-RAY CRYSTAL ANALYSIS. III

OTTO REINMUTH, ASSOCIATE EDITOR

In the previous articles of this series,[1,2] we have discussed some of the principles of X-ray diffraction and, assuming known structures for some very simple crystals, have inquired into the nature of the characteristic effects produced by the interaction of crystals and X-rays. It now remains to consider briefly the means whereby these principles are applied to the analysis of patterns obtained from crystals of unknown structure. No detailed or exhaustive exposition of analytical methods will be attempted. A grasp of these methods sufficient for creative work may well be left to the advanced or specialized student, whom the writer does not aspire to inform. The objective in the present series of articles is quite as modest as the title implies—namely, to give the general elementary student some intelligent notion of what it is all about.

Crystal Analysis a Process of Elimination

Since we have traced in some detail the effects produced when a crystal of sodium chloride is submitted to several of the principal methods of X-ray investigation, the uninitiated may have supposed off-hand that there exists some reverse operation whereby one may reason directly backward from an X-ray pattern of one sort or another to the crystal structure which produced it. In practice, however, analysis is not effected in quite this manner. The operation actually consists in selecting from among the number of theoretically possible structures that which must produce X-ray effects in closest agreement with the effects actually observed.

It should be made clear at the outset that it is not always possible to determine the exact structure (*i. e.*, the precise placement of each atom) of any and every crystalline material which may be submitted to examination. Sometimes it is impossible to obtain all the data necessary for so complete an analysis; sometimes other difficulties intervene. The nature of the obstacles to complete analysis will become more apparent as our discussion proceeds.

Crystal Symmetry

At first thought it might seem that there is an unlimited number of ways in which atoms may be arranged to form crystals. However, the symmetry conditions imposed definitely limit the number of possibilities.

[1] THIS JOURNAL, **7**, 138–50 (Jan., 1930).
[2] *Ibid.*, **7**, 860–72 (April, 1930).

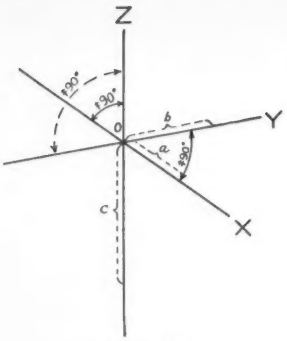


FIGURE 26

The axes of reference of point groups belonging to the triclinic system. The three axes are of unequal unit lengths ($a \neq b \neq c$) and make any angles with one another.

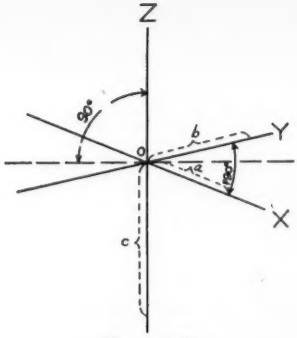


FIGURE 27

The axes of reference for the monoclinic point groups are of unequal unit lengths ($a \neq b \neq c$). Z is perpendicular to the plane of X and Y which, however, can make any angle with one another.

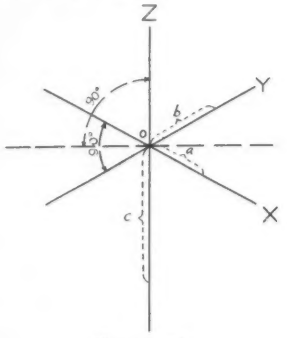


FIGURE 28

The axes of reference of the orthorhombic point groups. The three axes of unequal unit lengths ($a \neq b \neq c$) are mutually perpendicular.

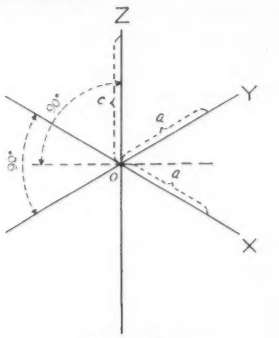


FIGURE 29

The axes of reference of the tetragonal point groups. The unit length along X and Y is different from that along Z ($a \neq c$).

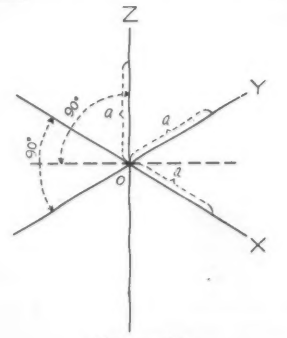


FIGURE 30

The axes of reference of the cubic point groups are three mutually perpendicular lines of equal unit lengths.

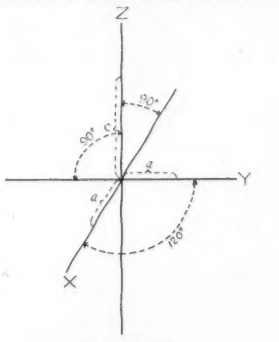


FIGURE 31

The hexagonal axes of reference. Two of these axes (X and Y) are of equal unit lengths and make an angle of 120° with one another; the third (Z) is of a different unit length and is normal to the plane of the first two.

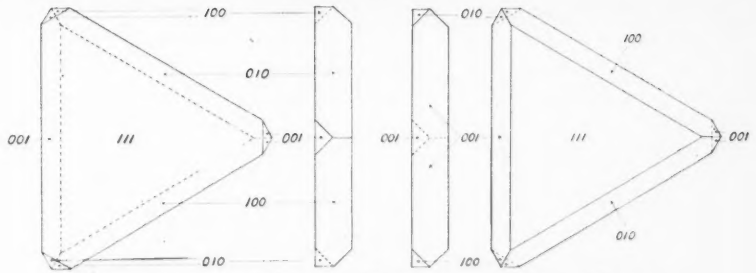


FIGURE 32.—FOUR VIEWS OF A THEORETICALLY POSSIBLE CRYSTAL

It has been mathematically demonstrated that the number of space groups possible is precisely two hundred thirty. These two hundred thirty space groups are distributed among thirty-two classes of crystal symmetry which are, in turn, divided among six main coördinate systems. The characteristics which distinguish these systems are set forth in Figures 26 to 31, after Wyckoff.

If the substance to be examined furnishes crystals large enough for optical examination, the system, and sometimes the class, of symmetry can be determined by crystallographic methods.

Crystallography is the study of the external symmetry of crystals. The fundamental symmetry characteristics of a crystal are revealed by the distribution of its plane faces and by various physical properties, such as growth characteristics, etc.

This is not to say that the symmetrical characteristics of a crystal are always immediately obvious from superficial observation. A substance belonging to the cubic system does not always crystallize in perfect cubes. For example, Figure 32 shows various views of a theoretically possible crystal which has the approximate form of a beveled triangular plate. Figure 33, however, indicates that it belongs to the cubic system.

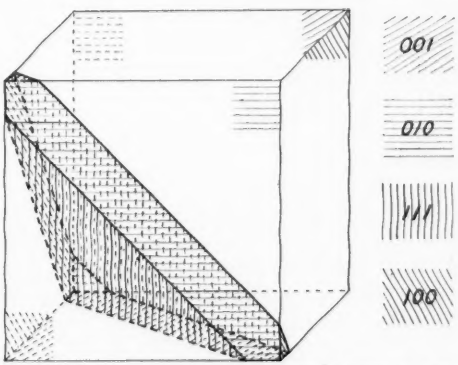


FIGURE 33.—SHOWING THAT THE CRYSTAL DEPICTED IN FIGURE 32 BELONGS TO THE CUBIC SYSTEM OF SYMMETRY

It is also possible to determine the system of symmetry of a macroscopic crystal by means of a stereographic projection of its Laue pattern. Stereographic projection is a geo-

TABLE I

(1) *Crystallographic Symmetry*	(2) *Symmetry of X-Ray Diffraction Effects*
I. Triclinic System	
1C, 1Ci	1Ci
II. Monoclinic System	
2c, 2C, 2Ci	2Ci
III. Orthorhombic System	
2c, 2D, 2Di	2Di
IV. Tetragonal System	
4c, 4C, 4Ci	4Ci
4d, 4c, 4D, 4Di	4Di
V. Cubic System	
T, Ti	Ti
Te, O, Oi	Oi
VI. Hexagonal System	
A. Rhombohedral Division	
3C, 3Ci	3Ci
3e, 3D, 3Di	3Di
B. Hexagonal Division	
6c, 6C, 6Ci	6Ci
6d, 6e, 6D, 6Di	6Di

metrical operation which converts the zone ellipses of the Laue pattern into true circles. The pattern so obtained may take any one of eleven characteristic forms. Table I, copied from Wyckoff, shows how it is possible, by determining the symmetry of the X-ray diffraction effects, to at once eliminate from consideration a large number of classes of symmetry. The letters and figures in the left-hand column indicate the thirty-two classes of crystal symmetry; the letters and figures in the right-hand column indicate the eleven types of X-ray diffraction effects.

It is also possible to assign indices to the spots in a stereographic projection of a Laue pattern but the procedure is rather complicated and the projection itself must be made with great accuracy. Since the symmetry of any crystal large enough to furnish a good Laue photograph may be determined optically, and since indices may be more readily assigned by means of the gnomonic projection, we shall not consider the stereographic projection in any detail.

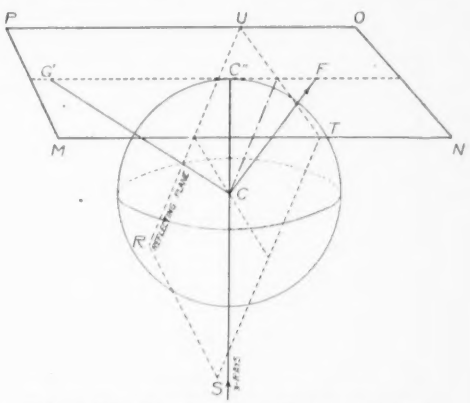


FIGURE 34.—THE GNOMONIC PROJECTION OF A LAUE SPOT.

The X-rays incident at right angles to the plane of projection and of the photograph (MNOP) are reflected by a plane RSTU (when extended) in a crystal at C, giving rise to a spot at F. By the gnomonic projection of the Laue spot F is to be understood the gnomonic projection of the reflecting plane RSTU. This point is G'.

Fundamentally, the gnomonic projection is a geometrical construction which registers the normals to the reflecting planes upon a projection plane. The projection plane may be the plane of the Laue photograph itself or some plane parallel to it, which means that the incident X-rays producing the photographs were directed normal to the plane of projection. Figure 34, after Wyckoff, clarifies the explanation. One of the significant characteristics of this projection pattern is that the projected points associated with the planes of any one zone all fall on a straight line and that they are regularly spaced along that line. A little consideration of the planes illustrated in Figure 15 of the second article of this series, together with the construction of a few appropriate diagrams, will reveal the geometrical causes which give rise to this happy circumstance.

In practice one does not bother to go through the details of an actual

geometrical construction for each spot. A specially designed rule shortens the process and makes it quite easy and simple. Figure 35 shows how the rule is applied.

In Figure 36 we see one quadrant of the gnomonic projection of a Laue photograph of rock salt. (Incidentally, this diagram contains some second- and third-order spots which were not shown in Figure 14 of the preceding article.) As is the case with all cubic crystals, the coördinate network is

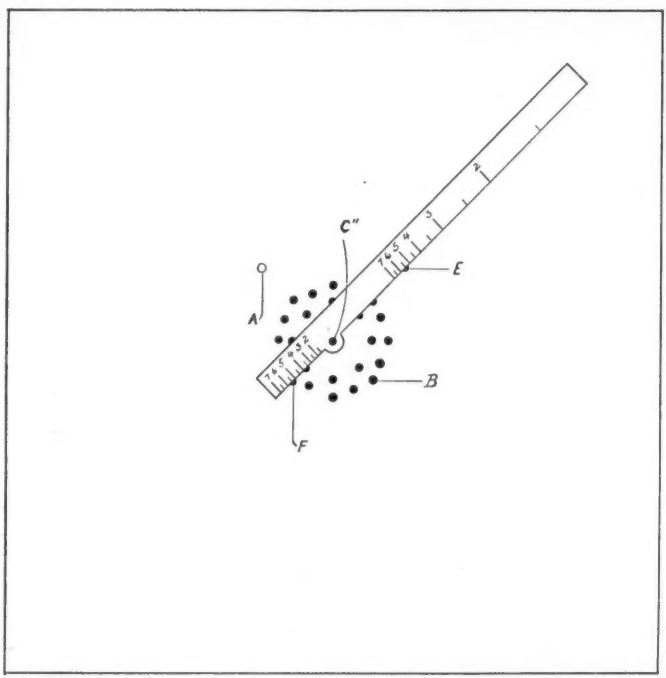


FIGURE 35.—ILLUSTRATING THE METHOD OF USING THE GNOMONIC RULE
E is the projection of F; A is the projection of B; C″ is the center of the Laue pattern, and also of the gnomonic projection. The spots have been exaggerated in size and reduced in number for the sake of simplicity.

square. The method of assigning indices is almost obvious from the diagram. It is evident that the values of h and k indices are determined by the coördinates and that the l index is always *one* for projections which fall at the intersections of coördinates. Employing the same system we would write the indices for the spot marked 173 as $\frac{1}{3}$, $2\frac{1}{3}$, 1. Since all indices must be whole numbers, however, we multiply these figures by three and obtain 173. Likewise, in the case of the spot marked 512

we would originally write $2\frac{1}{2}$, $\frac{1}{2}$, 1, which must be multiplied by two throughout.

The form of the coördinate network and the method of assigning indices varies somewhat with the symmetry of the crystal examined but the principles are the same throughout.

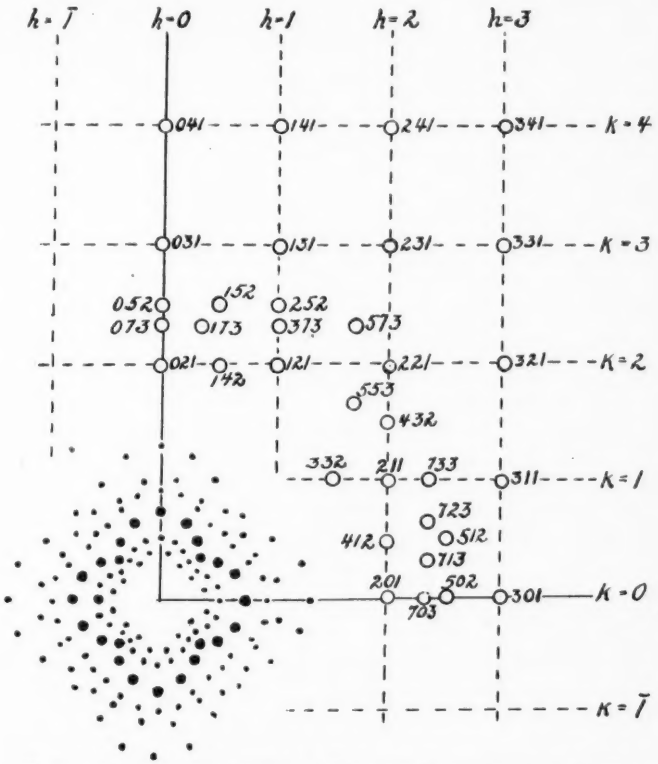


FIGURE 36.—ONE QUADRANT OF A GNOMONIC PROJECTION OF A LAUE PATTERN OF NaCl

The Mass Associated with a Possible Unit Cell

Assuming, then, that we have by some means established the system of symmetry of the crystalline material under investigation, the next step is to determine the mass associated with a crystallographically possible unit cell. In other words we must ascertain the number of molecules to a possible unit cell. For this determination we may assume a unit cell which has a shape defined by the customary axial ratios and angles.

For each system of symmetry there is a simple mathematical expression which gives the volume of the cell in terms of its axial lengths or of its axial lengths and angles. The simplest expression of all is that for the cubic system:

$$V = a_0^3 \qquad (1)$$

where a_0 is the length of the cube edge. The volume of the cell (V) is related to the mass of the cell and the density of the crystal as follows:

$$\rho = mM/V \qquad (2)$$

Here ρ is the density of the crystal, m is the number of molecules associated with the unit cell, and M is the mass of its chemical molecule. M is obtained by multiplying the molecular weight of the compound by 1.65×10^{-24} grams.

Combining equations (*1*) and (*2*), we obtain:

$$\rho = mM/a_0^3 \quad \text{or} \quad m = \rho a_0^3/M \qquad (3)$$

However, our equation still contains one unknown quantity (a_0) beside the one for which we hope to solve (m). The quantity a_0 cannot be determined directly but it can be calculated if the spacing for any set of planes (d_{hkl}) has been determined.

The spacing of a set of planes can be calculated if a reflection of monochromatic rays of known wave-length from a corresponding crystal face has been obtained. (Modification of the Bragg method.) The familiar equation, $n\lambda = 2d_{hkl} \sin \theta$, is employed.

The experimentally obtained quantity, d_{hkl}, can then be placed in the following equation, which allows us to solve for a_0:

$$d_{hkl} = d_{100}/(h^2 + k^2 + l^2)^{1/2} = a_0/(h^2 + k^2 + l^2)^{1/2} \qquad (4)$$

We are then able to solve equation (*3*).

Similar but somewhat more complicated equations have been derived for the other coördinate systems.

The Correct Unit Cell

Having established the symmetry characteristics of a crystal by optical examination or by the study of Laue patterns, and having calculated the mass associated with a possible unit cell, we must next choose the correct or "true" unit cell. This is defined as the smallest prism which by simple repetition along the coördinate axes will build up the entire crystal.

If our crystal belongs to the cubic system we are not faced by any embarrassment of choice as to the shape of the cell, for cubic axes can be drawn in only one way. Our sole problem is concerned with the proper size of the cell. In actual practice we choose the smallest cell which agrees with the experimental data. In some of the other systems of symmetry

the choice is much more difficult, and, while it is often possible to choose a cell consistent with the experimental data, an enormous amount of labor is involved in eliminating all other possibilities.

Selecting the Correct Structure

Assuming that we have now arrived at a knowledge of the symmetry of our crystal, of the number of molecules associated with the unit cell, and of the correct unit cell, it now remains to apply the theory of space groups, and to choose from among the possible structures that one which best agrees with the diffraction data. For the sake of being specific let us take sodium chloride.[4]

Optical examination and the study of projections of Laue patterns, tell us that the sodium chloride crystal must belong to the class of symmetry designated as Oi in Table I. There are no data of any kind which would lead us to think that there are more than four molecules associated with a unit cell, and the unit cell must, of course, be a cube. By referring to such tables as those compiled by Wyckoff[5] we find that for these conditions there are only four conceivable sorts of arrangement. The four sodium ions in the unit (1) might be similarly related to one another, or it may be imagined (2) that three of them are alike but different from the fourth, (3) that two of them are different from the other two, or (4) that all four are unlike.

(1) If the four sodium atoms are equivalent and the four chlorine atoms are also equivalent, the following atomic arrangements are seen to be possible:

(*a*) (Figure 37) Na: 000; $0\frac{1}{2}\frac{1}{2}$; $\frac{1}{2}0\frac{1}{2}$; $\frac{1}{2}\frac{1}{2}0$.
Cl: $\frac{1}{2}\frac{1}{2}\frac{1}{2}$; $\frac{1}{2}00$; $0\frac{1}{2}0$; $00\frac{1}{2}$.

(*b*) (Figure 38) Na: $\frac{1}{4}\frac{1}{4}\frac{1}{4}$; $\frac{1}{4}\frac{3}{4}\frac{3}{4}$; $\frac{3}{4}\frac{1}{4}\frac{3}{4}$; $\frac{3}{4}\frac{3}{4}\frac{1}{4}$.
Cl: $\frac{3}{4}\frac{3}{4}\frac{3}{4}$; $\frac{3}{4}\frac{1}{4}\frac{1}{4}$; $\frac{1}{4}\frac{3}{4}\frac{1}{4}$; $\frac{1}{4}\frac{1}{4}\frac{3}{4}$.

By transferring its origin to the point $\frac{1}{4}\ \frac{1}{4}\ \frac{1}{4}$ the second arrangement is, however, shown to be identical with the first.

(2) If three of the atoms of a chemical kind are equivalent but different from the fourth:

(*c*) (Figure 37) Na: 000; $\frac{1}{2}\frac{1}{2}0$; $\frac{1}{2}0\frac{1}{2}$; $0\frac{1}{2}\frac{1}{2}$.
Cl: $\frac{1}{2}\frac{1}{2}\frac{1}{2}$; $00\frac{1}{2}$; $0\frac{1}{2}0$; $\frac{1}{2}00$.

(*d*) (Figure 39) Na: 000; $00\frac{1}{2}$; $0\frac{1}{2}0$; $\frac{1}{2}00$.
Cl: $\frac{1}{2}\frac{1}{2}\frac{1}{2}$; $\frac{1}{2}\frac{1}{2}0$; $\frac{1}{2}0\frac{1}{2}$; $0\frac{1}{2}\frac{1}{2}$.

In the positions of its atoms arrangement (*c*) is indistinguishable from (*a*) and (*b*).

(3) If the chemically like atoms fall into two groups of two geometrically equivalent atoms each: Since there is but one group of two equivalent positions possessing cubic symmetry, no arrangement of this sort is possible.

---

[4] The succeeding analysis is practically an abstract of that given by Wyckoff, "The Structure of Crystals."

[5] "An Analytical Expression of the Results of the Theory of Space Groups," Publ. 318, Carnegie Institution of Washington.

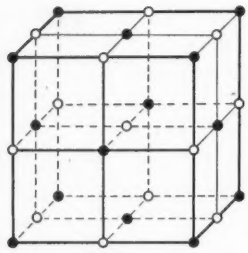


FIGURE 37

Structure *a*

Na: 000; 0½½; ½½0
Cl: ½½½; ½00; 0½0; 00½.

Structure *c*

Na: 000; ½½0; ½0½; 0½½.
Cl: ½½½; 00½; 0½0; ½00.

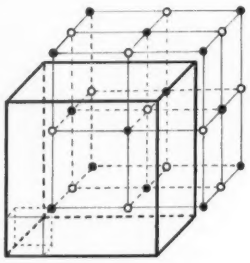


FIGURE 38

Structure *b*

Na: ¼¼¼; ¼¾¾; ¾¼¾; ¾¾¼.
Cl: ¾¾¾; ¾¼¼; ¼¼¾; ¼¾¼.

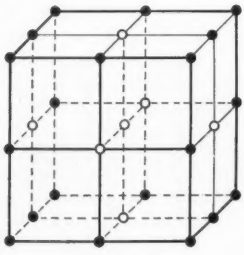


FIGURE 39

Structure *d*

Na: 000; 00½; 0½0; ½00.
Cl: ½½½; ½½0; ½0½; 0½½.

(4) If the four chemically like atoms are non-equivalent to one another: Since there are only two groups of singly equivalent positions in space groups with cubic symmetry, no such arrangement is possible.

Hence we arrive at the conclusion that we have only to choose between the structures illustrated in Figures 37 and 39. Again we return to our X-ray diffraction data. Mathematical formulas, with which we shall not bother here, have been derived for the calculation of the "reflections" which may be expected from these types of structure.

Applying such formulas we find that if sodium and chlorine are assumed to have appreciably different refraction powers (an assumption well justified by experiment) we shall get for:

Structure *a*.—

Relatively faint odd-order reflections for all sets of planes for which *h*, *k*, and *l* are all odd;

No other odd-order reflections;

Strong even-order reflections for all sets of planes.

Structure *d*.—

Relatively faint odd-order reflections when *h*, *k*, and *l* are all odd.

Relatively faint odd-order reflections when *h*, *k*, and *l* are two even and one odd.

Strong even-order reflections for all sets of planes.

Since the experimental data are actually those which would be predicted for structure *a* (Figure 37) we choose that structure.

Intensities of Reflections

We should not conclude without a brief note concerning the significance and determination of relative intensities of reflections. The following generalizations are roughly but not exactly true.

(1) The diffracting power of a crystal element (ion, atom, or molecule) is proportional to the number of extra-nuclear electrons.

(2) The intensity falls off more or less regularly toward higher orders. The apparent exceptions to these rules are explainable upon the basis of a more detailed study of the relation of structure to diffraction effects.

For simple problems like the one we have just considered it is sufficient to estimate intensities visually as strong, medium, or weak. A more exact estimation is sometimes attempted on a basis of zero to ten, ten being the highest intensity. Where differentiations of this order are necessary it is usually desirable to employ the ionization spectrometer. (Photometric methods are also possible and are often employed.)

The ionization spectrometer takes advantage of the fact that X-rays ionize gases and that the degree of ionization is proportional to the intensity of the radiation. The degree of ionization is readily measurable by means of the conductivity. In the investigation of intensities we would, then, bring an ionization chamber successively into positions necessary to trap and measure the "reflections" from a number of important, previously determined sets of planes.

Summary

To summarize, the complete analysis of a crystal involves:

1. Assignment to a system and, if possible, a class of symmetry by means of optical examination or Laue patterns or both.
2. Calculation of the mass associated with a possible unit cell (which leads to the number of molecules per unit cell).
3. Selection of the proper unit cell.
4. Application of the theory of space groups to ascertain to which of the possible 230 groups the crystal actually belongs.
5. Choice of correct structure after consideration of the "reflections" present and their relative intensities.

We have not dealt with any of these operations exhaustively nor in any detail, and we have considered only an extremely simple and easy example. More complicated cases and more detailed study of methods are for the advanced or special student.

We should note that not all the data necessary for a complete analysis are always obtainable. (Often, for instance, it is impossible to grow crystals large enough for optical examination or for Laue or Bragg treatment.) In the case of cubic crystals and occasionally of simple hexagonal crystals it is possible to effect an analysis without complete data. In other cases incomplete data almost inevitably means that incomplete analysis, only, is possible.

Acknowledgment

The writer desires to express gratitude to Dr. Emil Ott of The Johns Hopkins University for reviewing this manuscript and to Miss Marguerite Little of the JOURNAL staff for aid in preparing some of the illustrative diagrams employed.

He also acknowledges his indebtedness to the following references:

W. P. Davey, "Study of Crystal Structure and Its Applications," *Gen. Elec. Rev.*, **27,** 742–8, 795–802 (1924); **28,** 129–37, 258–65, 342–8, 586–99, 721–30 (1925); **29,** 118–28, 274–87, 580–9 (1926).

Sir William H. Bragg, "An Introduction to Crystal Analysis," D. Van Nostrand Co., Inc., New York, American edition, **1929.**

Sir William H. Bragg and W. L. Bragg, "X-Rays and Crystal Structure," G. Bell & Sons, Ltd., London, fourth edition, **1924.**

R. W. G. Wyckoff, "The Structure of Crystals," The Chemical Catalog Co., Inc., New York, **1924.**

George L. Clark, "Applied X-Rays," McGraw-Hill Book Co., Inc., New York, first edition, **1927.**

F. K. Richtmyer, "Introduction to Modern Physics," McGraw-Hill Book Co., Inc., New York, first edition, **1928,** Chapter XII.

Britain Honors 1929 Nobel Prize Winners. So little notice was taken by the public press of Great Britain of the award of Nobel prizes, except the prizes for literature and peace, that the banquet given on February 3rd by the Biochemical Society in honor of the Nobel Laureates in medicine and chemistry last year is of particular interest. In Sweden the prizes are rightly regarded as of outstanding and world-wide importance, and when they are presented on the anniversary of Alfred Nobel's death, the head of the State is present, and the ceremony is conducted with impressive solemnity and dignity. The Swedish people show that they are proud of the great foundation with which Nobel entrusted them, and the nation delights to associate itself with the progressive thought and work of the recipient of the prizes. British Laureates find a very different atmosphere prevailing when they return to their own shores; and it is not surprising to know that this public indifference is not understood in Sweden. The three Laureates in medicine and chemistry who were present at the dinner were Sir Frederick Gowland Hopkins, Prof. Hans von Euler, and Prof. Arthur Harden. Prof. C. Eijkman was unfortunately unable to attend, owing to ill health.

Sir Charles Martin presided at the banquet, which was largely attended, among the company being the Swedish Minister and Sir Ernest Rutherford, president of the Royal Society. In proposing the toast of "The Nobel Laureates," Sir Charles Martin gave a very interesting survey of the growth of knowledge of accessory food factors from the time when Eijkman became director of the pathological laboratory at Weltevreden to the present period of marvelous activity. Beriberi was then regarded as an infection, and it was Eijkman's experiments which showed that the disease was similar to a disease in fowls and due to a dietetic deficiency. Turning to Sir Frederick Hopkins, the chairman hailed him as a prince of biochemists who has enriched physiology for forty years by his discoveries. From his experiments with synthetic diets he was led to conclude that for nutrition certain minute quantities of hitherto unknown substances were essential; and so began our knowledge of vitamins. Prof. Harden's researches began with the fermentations of bacteria by accurate quantitative methods, and developed into his brilliant work on alcoholic fermentation. His discoveries have brought about completely new conceptions of the chemistry of these changes. Prof. von Euler's explorations in the same field have been most extensive, and there is scarcely any aspect of the subject that he has not illuminated by his researches.—*Chem. & Ind.*

TWO MODELS FOR THE ILLUSTRATION OF INDUSTRIAL PROCESSES

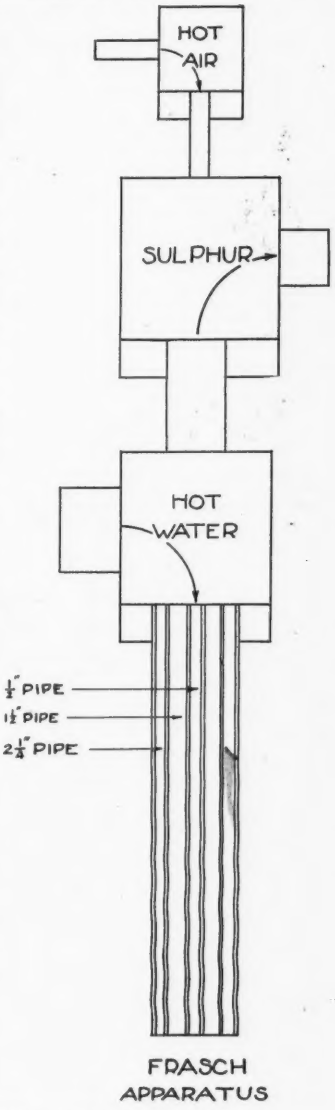
S. C. DENNIS, GIRARD COLLEGE, PHILADELPHIA, PENNSYLVANIA

In two previous notes[1] the writer has described a miniature contact-process sulfuric acid plant and a working model of a plant nitrator designed and constructed by students in the industrial chemistry courses at Girard College.

The construction and operation of an actual working model do not, however, exhaust the possibilities of this type of project. Often a static or diagrammatic model is very useful as an aid to visualization in explaining the operation of a process. Two such models are described in the present note.

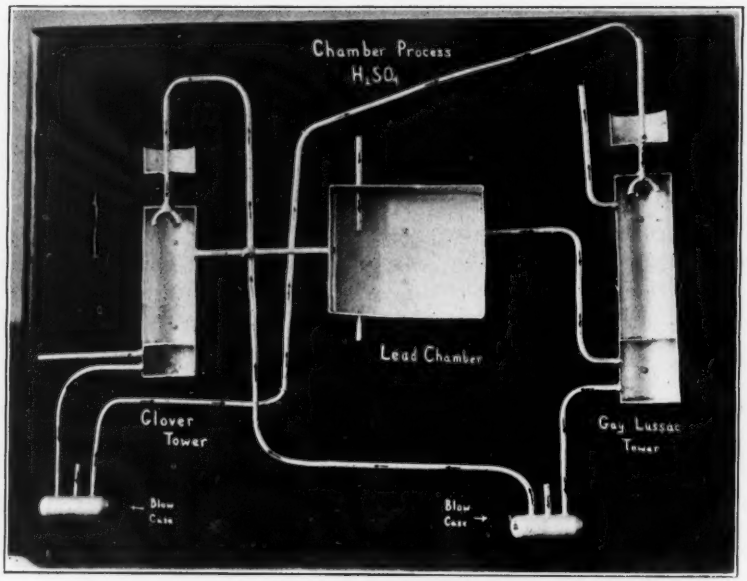
Frasch Apparatus Model

The principles and essentials of practice of the Frasch process for the mining of sulfur are so well-known that there is no point in elaborating upon them.[2] The Frasch model here illustrated consists of three concentric pieces of brass tubing, mounted by means of blocks of wood on a vertical support. The tubes are one-fourth, one and one-half, and

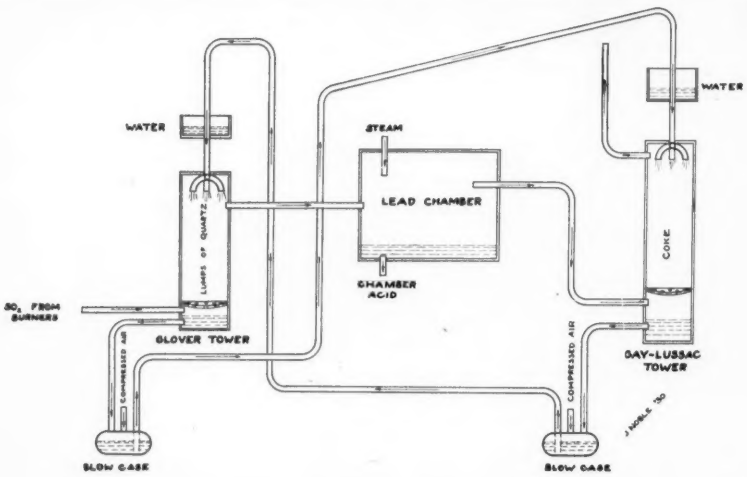


[1] THIS JOURNAL, *6*, 1781–3 (Oct., 1929); *Ibid.*, *7*, 434–5 (Feb., 1930).

[2] Those who desire a simple review of the process will find one in THIS JOURNAL, *6*, 129–38 (Jan., 1929)



two and three-quarters inches in diameter, respectively. The two lower blocks are three by three inches square and three inches deep, while the upper block is two by two inches, and three inches deep. In addition to supporting the tubes, the blocks serve as connections with the outlets



and as labels for the tubes. The vertical support, which is hung on the wall, is ten by fifty-two inches.

Model Illustrating Chamber Process for Sulfuric Acid

The chamber process for the manufacture of sulfuric acid is described in practically all texts on general chemistry and diagrammed in most of them. Nevertheless, we have found a diagrammatic model of considerable aid in class discussions of the process.

The lead chamber is made of thin sheet iron ($6'' \times 5'' \times 2\frac{1}{2}''$). Connecting pipes are of brass tubing, one-half inch in diameter. The Glover tower is six and one-half inches high and two and one-quarter inches in diameter, and the Gay-Lussac tower nine inches high and two and one-half inches in diameter. Blow cases are made of steel, three inches long, and one inch in diameter. The assembled unit is mounted on a wooden base thirty-one inches long and twenty-two inches wide.

John Kunkel. Three hundred years ago—it was in 1630, but we confess with humility our ignorance concerning the day or even the month—there was born in the Duchy of Schleswig one John Kunkel, alchemist, chemist, and pharmacist, who, like Boyle, valiantly attacked the duplicity and charlatanism with which the "science" of transmutation had become associated. "He was scornful of the theories of the adepts," says Sir Edward Thorpe, "and contemptuous of their *tria prima*." An alchemist, nevertheless, he could invent a quaint name for the alkahest—"Alles Lügen ist." Apart, however, from his alchemical study and criticism, he devoted himself in particular to the processes of the manufacture of glass and to the assaying of metals. When twenty-nine years of age he held the post of chemist and chief apothecary to the Dukes of Lauenburg, whence he was later called to be superintendent of the laboratory of the Elector of Saxony; he next went to Berlin, entering the service of Frederick William, Elector of Brandenburg, and finally to Stockholm, where Charles XI accorded him the title Counselor of Metals, and ennobled him as Baron von Löwenstern. It was at Stockholm that Kunkel died in 1702. Despite his important contributions to glass technology (in the manufacture of ruby glass), metallurgy (in the separation of gold and silver), organic chemistry, and the processes of fermentation, Kunkel is probably best remembered on account of his connection with the discovery of phosphorus. First prepared by Brand in 1669, phosphorus was at that time, of course, a remarkable curiosity. It appears that one Kraft, a friend of Kunkel, somewhat treacherously forestalled the latter in obtaining sole possession (for a financial consideration) of the secret of its manufacture; hence Kunkel's successful preparation deserves to be regarded practically as an independent discovery, for his only information was the source from which Brand had obtained the new element. In 1678 he published a treatise on "phosphorus mirabilis," and even proposed its internal medicinal use in pills. Dr. Thomas Thomson remarks that Kunkel's most valuable work, his treatise on glass making, remained until nearly the end of the eighteenth century by far the best account of that art in existence. Of his posthumous work, "Laboratory chymicum," Thomson says: "It must have been valuable, as it was the work from which Scheele derived the first rudiments of his knowledge."—*Chem. & Ind.*

CHEMISTRY FOR THE AMATEUR PHOTOGRAPHER. VI. PRINTING AND TONING*

A great number of different processes have been used at one time or another for printing negatives. The earliest printing processes depended upon the fact that silver compounds darken in light, and the first printing paper to be used generally was made by soaking a sheet of paper in a solution of table salt and washing this over with a solution of silver nitrate so as to convert the salt into silver chloride. Paper so prepared was known as "salted" paper on which, after exposure to light behind a negative, a print was obtained which could be toned by the deposition of gold from a solution and then fixed with hypo. A better paper was made by using albumen obtained from the white of eggs. After adding salt to it the albumen was spread over the surface of the paper and then sensitized by treatment with a solution of silver nitrate.

After the gelatin process for negatives was discovered gelatin emulsions were applied to printing papers. Gelatin paper was made by emulsifying silver chloride in gelatin with an excess of silver nitrate and then coating it on paper just as films are coated with the sensitive negative emulsion. The typical gelatino-chloride paper of this type is Solio.

To use Solio, the negative is put in a printing frame, and the paper is put with its coated side in contact with the emulsion side of the negative and pressed into contact by closing the back of the printing frame. The frame is then exposed to daylight and the image printed on the paper, which darkens to a brownish red color. From time to time the depth of the printing is observed by opening the back of the frame. The image must be printed to a somewhat darker color than will be required in the finished picture. When printed the paper is removed in a subdued light and the print is toned by immersing in a solution containing gold so that the metallic gold is deposited on the print, giving it a purple color. After toning, the print is fixed in a hypo solution and washed. A toning process is necessary with all printing-out silver papers, such as Solio, albumenized paper, or salted paper, because if the printed-out silver image is fixed without toning, the fixing bath changes it to an ugly yellow color and a very poor-looking print results. The gold toning produces a rich-looking, permanent image which varies in color from brown to purple; these colors, indeed, used to be regarded as the only satisfactory colors for photographs.

The chief use for printing-out papers at the present time is for the making of photographers' proofs. For this purpose the negatives are printed, but the prints are not toned or fixed, and while they are satis-

* This series of articles is based upon selected chapters from "Elementary Photographic Chemistry" and "The Fundamentals of Photography," published by the Eastman Kodak Company, Rochester, New York. Cuts are by courtesy of the Eastman Kodak Company.

factory for examination, they cannot be kept because they darken in the light, the photographer supplying them only as samples to show the pose and expression, and making permanent prints to order later.

Quite early in the history of photography it was discovered that many substances besides the salts of silver are sensitive to light. One process of printing, the platinum process, is founded upon the sensitiveness to light of iron salts. If paper is coated with ferric oxalate, which is a green, soluble salt of iron, and this is exposed to light, the ferric oxalate is changed into ferrous oxalate, which is insoluble, so that a sheet of paper thus prepared and printed will, after washing, give a faint image consisting of ferrous oxalate. If, to the ferric oxalate with which the paper is prepared, a solution of a platinum compound is added and then, after printing, the faintly visible image is put into a solution of a soluble oxalate, the ferrous oxalate is dissolved and attacks the platinum salt, which is not affected by the ferric oxalate, precipitating metallic platinum on the paper so that an image is obtained consisting of black metallic platinum.

Another process depends upon the fact that gelatin containing bichromate becomes insoluble in water on exposure to light, and this process is known as the "pigment" process or more commonly as the "carbon" process, the name being derived from the fact that the gelatin used in the early days of the process contained finely divided carbon or lamp black to act as a pigment. Such a printing paper is made by coating the paper stock with a thick gelatin solution containing finely divided pigment suspended in it. The pigment is chosen according to the color of the print required. For a black image it may be lamp black, for a red image red ochre or burnt sienna, and for images of other colors any permanent and stable pigment of the color desired which can be finely powdered. After the coated gelatin has been dried the paper is immersed in a solution of ammonium or potassium bichromate or ammonia and again dried. This bichromated gelatin is quite soluble in hot water, but if it is exposed to light it becomes insoluble where the light has acted upon it. The bichromated gelatin is, therefore, printed under the negative in the same way as a Solio print. No visible image is produced, and to get the visible print it is necessary to wash away the soft gelatin. The gelatin, which has been hardened by the action of light, is on the surface of the print and the soft gelatin is at the back, so in order to develop the print it is put face down onto another sheet of paper and placed in hot water. After a short time the soluble gelatin begins to ooze out at the edges of the print and the whole of the original paper can be pulled off, leaving the image covered with a sticky mass of partly dissolved gelatin on the paper to which it has been transferred. This image is then washed in hot water until all the soluble gelatin has been washed away, leaving a clear image of the pigmented gelatin on the paper.

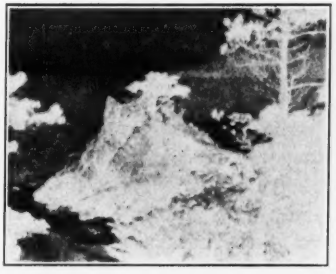
All these printing-out processes require a long exposure to strong daylight, and they have become more or less obsolete owing to the trouble of working them and especially the difficulty of judging the correct exposure with such a variable illuminant as daylight. They have been displaced by printing processes in which the paper used is coated with an emulsion. This paper, known as development paper, is exposed behind the negative and is then developed, in the same way as a negative, to give a visible image.

The oldest of these development papers is bromide paper. This paper is coated with an emulsion very similar to the ordinary negative emulsions but of somewhat less sensitiveness. The paper is very sensitive to light and must be worked by red or orange light only. The exposure for printing is, of course, very short and the paper is, in fact, mostly used for enlarging, the image of the negative being thrown upon the sensitive bromide paper by a projection lantern so as to obtain an enlarged picture from the negative.

About 1894 Velox paper was introduced and was an entire novelty, since, while it is similar to bromide paper in that it is exposed to an artificial light and then developed and fixed, it is so much less sensitive than bromide paper that it can be worked in a room lighted by a weak artificial light and does not require a special darkroom, from which fact it was known as "gaslight" paper. Since the introduction of Velox other "gaslight" papers have been made and at present almost all prints made by contact from negatives are made on papers of this type. Velox is about a thousand times slower than bromide paper so that it can be handled safely in any subdued light. It requires an exposure that ranges from about 2 seconds to about a minute, depending on the density of the negative and the grade of Velox used, at one foot from a 25-watt Mazda lamp, and it is characterized especially by the extreme rapidity and ease of its development, from which its name is derived, developing fully in about 30 seconds. It is consequently possible by using Velox to make prints in comfort and with great rapidity, the old troubles of judging the extent of the printing, and the difficulties with toning baths being entirely absent with this simple and convenient printing medium.

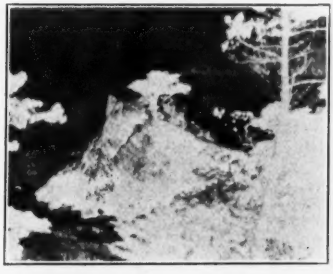
Velox paper is made in grades of contrast to fit different types of negatives. The paper was originally made in one grade only but later it was found necessary to supply other grades suitable for negatives of varying contrasts.

If we make three negatives of the same subject in succession, giving each exactly the same exposure, and then develop these for different lengths of time so that the first will be under-developed, the second correctly developed, and the third over-developed, the first negative will have a short range of contrast, the second a medium range, and the third a long



Soft negative of little contrast

Print from opposite negative on No. 4 Velox



Average negative of medium contrast

Print from opposite negative on No. 3 Velox

Hard negative of strong contrast

Print from opposite negative on No. 2. Velox

FIGURE 1

range. If we then print the first negative on No. 4 Velox, the second on No. 3 Velox, and the third on No. 2 Velox, we shall get almost identical prints on all three papers provided that the contrasts of the negatives just fit the various grades of the paper. This is shown in Figure 1.

We might think that No. 4 Velox would always give a more contrasty print than No. 3 Velox; it will if both papers are printed from the *same* negative, but if the No. 4 Velox is printed from a flat negative and the No. 3 Velox from a normal negative, then the No. 4 Velox will compensate for the flat negative and give a *normal* print, just as the No. 3 Velox gives a *normal* print from a normal negative, and the No. 2 Velox a *normal* print from a contrasty negative. Sometimes a negative of a contrasty subject is over-developed so that it gives too contrasty a print even on No. 2 Velox. For this type of negative the very soft-working No. 1 Velox has been provided.

FIGURE 2.—DEGREES OF LIGHT INTENSITIES

FIGURE 3.—RANGE OF 44 DISTINCT TONES

All the grades of Velox give the same range of reflecting powers in the print provided that they are used with negatives which will enable this range to develop. Suppose we take a black wedge which contains all the degrees of light intensities, from absolute opacity at one end to absolute transparency at the other end and make a print of it. We should get the result shown in Figure 2. This shows the entire range of reflecting power of which the paper is capable, the range varying from white paper at one end to the blackest silver deposit which the paper can give, at the other.

With any "velvet" surface paper, such as Velvet Velox, we shall find that the white paper will reflect about twenty-five times as much light as the deepest silver deposit. The number of distinct tones which are included in this range from white to black depends, of course, on the ability of the eye to distinguish them. The eye can actually see about one hundred distinct tones in such a range.

In Figure 3 is shown a range of tones made up, not as a continuous

wedge, but of forty-four distinct tones. The number which can be seen in the illustration is less than the number which the eye can distinguish in a print because of the limitations imposed by the process of halftone reproduction. If the full one hundred tones which the eye can distinguish in a print were reproduced by the halftone process the halftone illustration would look like a continuous wedge.

In Figure 4 the same wedge has been printed on all three papers, and it will be seen that No. 4 Velox has reached its full blackness only a short distance up the wedge, No. 3 Velox has gone farther, and No. 2 Velox has gone the farthest of all, so that while all three papers will give the same range of tones, this range is impressed on No. 4 Velox with only a short range of densities in the negative; for No. 3 Velox a longer range is needed, and for No. 2 Velox a still longer range.

The range of densities required in a negative to just print out the full range of tones on a paper is called the "scale" of the paper and this is measured by trying an increasing series of exposures until the range of exposures which will just give the whole range of tones on the paper is found; that is, if an exposure of one second to the bare paper with no negative will just give the first perceptible difference from white paper, so as to show the first trace of tint on the paper, and an exposure of twenty seconds will give the deepest black the paper is capable of rendering, so that no increase of exposure will produce any denser black, then we should call the scale of the printing paper 1 to 20.

No. 4 Velox | No. 3 Velox | No. 2 Velox

FIGURE 4

Thus the word "scale" applied to a printing paper does not refer at all to the range of tones in the print. It indicates the range of contrast in the negative which should be printed on that paper. A paper with a scale of 1 to 20 will require a negative in which the densest part lets through $^1/_{20}$ of the light transmitted by the clearest part, because if this negative is printed on that paper the print will just have the whole range of tones from white to black completely printed out, each tone in the print corresponding to a density in the negative, there will be no differences of density in the negative unrepresented by differences of tone in the print.

No. 1 Velox has a scale of about 1 to 30 and is used only for very contrasty negatives. No. 2 Velox has a scale of about 1 to 20 and is suitable for printing from contrasty negatives. No. 3 Velox has a scale of about

FIGURE 5.—PRINT SHOWING EMPTY HIGH LIGHTS

1 to 10 and is suitable for printing from negatives of moderate contrast, while the very flattest and least contrasty negatives, which are the result either of excessive over-exposure or under-development should be printed on No. 4 Velox, which has a scale of about 1 to 5.

It is important to choose the grade of paper correctly for the negative. If the paper is too contrasty for the negative; if, for instance, we print a hard negative (one that has strong contrast) on No. 4 Velox, then we shall have to sacrifice a part of the scale of the negative; either we shall get the high lights empty and white, as shown in Figure 5, or we shall get the shadows blocked up, as shown in Figure 6. On the other hand, if the scale of the paper is too long for the negative and we print a soft negative (one that has little contrast) on No. 2 Velox, for instance, when we should have used No. 3 Velox, then we shall get a gray, flat print, as is shown in Figure 7.

With paper, as with film, the density of the picture is controlled by the duration of the exposure and the development, but whereas with films the contrast is dependent upon the time of development, the contrast increasing as the development is continued, with paper the contrast is fixed by the maker, and after a few seconds the development does not change the contrast of the print at all but only affects the density of the deposit.

If a print is over-exposed, it can be taken out of the developer before it is fully developed, and if under-exposed, it can similarly be forced in

FIGURE 6.—PRINT SHOWING BLOCKED SHADOWS

development, though there is some risk of yellow stain if development is continued too long. The best results can, of course, only be obtained by getting the exposure right and giving the normal time of development, which is about 30 seconds. The matter of greatest importance for getting really first-class prints, therefore, is to give them the right time of exposure.

Before starting to print a number of negatives they should be classified for contrast so as to choose a suitable grade of paper for printing them; that is to say, put the negatives in envelopes according to the grade of Velox on which they are to be printed. Now take the negatives in each of these envelopes and divide them again into three more classes—normal negatives having average density, thin negatives, and dense negatives. When printing, if we take the exposure for the normal negative as standard, then the thin negatives will require half this standard exposure and the dense negatives will require twice, while sometimes we may possibly meet an exceptional negative—very thin or very dense—which may require one-fourth or four times the standard exposure. Having classified our negatives in this way, in order to get our exposures right we need know only the exposure on each grade of Velox paper for our standard negatives, and if we print with a 25-watt Mazda lamp at a distance of one foot, we shall find that the exposure for a standard negative will be about 20 seconds for No. 2 Velox, about one minute for No. 3, and one and a half minutes for No. 4. These figures are to be taken only as a guide, and when a new light or a new package of paper is used for the first time, trial exposures should be made with the standard negative, giving, say, 15, 20, and 30 seconds' exposure, so as to select the exposure which develops to the right density with the correct time of development.

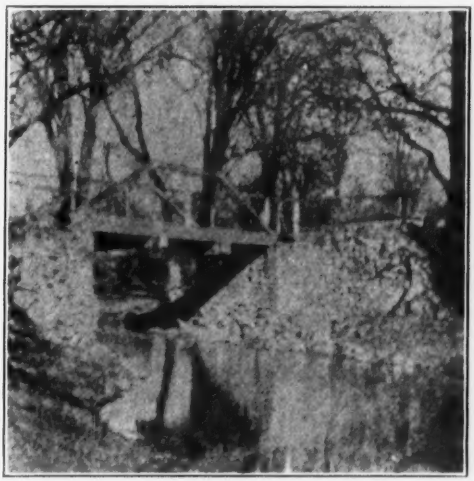


FIGURE 7.—GRAY, FLAT PRINT

It is best always to use the same standard negative for testing a new paper or a new printing lamp and any other new conditions that may arise in printing, as more useful information will be gained by making tests with

one negative only than if a different negative is selected each time a test is to be made.

If the subject of exposure is dealt with in this way, if the negatives are classified for density before printing, and a test is made on a standard negative, it will be found easy to print a large number of negatives on several grades of Velox paper and get a very high percentage of first-class prints with normal development.

With regard to development and after-treatment of the print, there is very little to say, since the matter is fully explained in the instruction sheets furnished by the manufacturers. It is best to buy the ready prepared developers such as Velox Liquid Developer or Nepera Solution and to follow the directions given.

FIGURE 8.—ENLARGEMENT OF PART OF A SNAPSHOT

When fixing prints, take care that they do not lie on top of one another in the fixing bath without change so that each print will get its supply of fresh acid hypo.

Enlarging

While contact prints are satisfactory to show one's friends, a time comes when we want to attempt something more ambitious and to make photographs which we can hang on our walls or submit for exhibition, and then we feel that we want something more than an ordinary print and something more than an enlarged print; we want to make a picture. The difference between a picture and a print is, of course, not a matter of size; it is a matter of composition and balance, of judgment in the choice of subject and of the moment of exposure, and of finish and quality in the result.

The great value of enlarging is that parts can be chosen from a negative and enlarged to make very pleasing pictures, where the whole negative if printed as a contact print would be by no means satisfactory. The print shown in Figure 8, for instance, is an enlargement of a film negative. This negative was taken at the seashore as a snapshot exposure, the figures being very small and in the corner of the negative so that if the negatives were printed as a whole it would be very unsatisfactory. While a contact

print, trimmed as is shown in the enlargement, was not much larger than a postage stamp, an enlargement of the figures in it, however, made a pleasing picture.

Another illustration of what can be done in enlarging is shown in Figure 9, where two negatives have been enlarged together to make a combined picture. The lower half of the original scene, of which the church and trees form the upper half, consisted of a ploughed field, so that the foreground in the original negative was very unsatisfactory. By taking another foreground, however, taking care, of course, that the lighting was the same, and shading the foreground of the first negative so that it did not print in enlarging, then changing the negative in enlarging and substituting the foreground negative, the two have been printed into one another with the result shown. Some photographers are very clever at making these combined enlargements.

FIGURE 9.—COMBINED ENLARGEMENT FROM TWO NEGATIVES

The introduction of vertical enlargers, in which the focus is maintained automatically while the degree of enlargement is varied, has made enlarging a very simple operation.

When making enlargements from negatives of varying quality, the enlargement can very often be improved by controlling the exposure, allowing more or less time on different parts of the print.

Practically all negatives, except those that were badly under-exposed, contain much delicate detail that is scarcely noticeable in a small contact print but is clearly seen in an enlargement. The absence of detail in parts of the light or dark tones of a small picture is not displeasing, but in the case of an enlargement these areas, being larger, are much more conspicuous and would be improved if more detail could be obtained. If the negative shows detail in these areas, it can be recorded in the enlargement, and, what is of even greater importance, the contrast between the various tones of the picture can also be increased or decreased as much or as little as desired by locally controlling the exposure when making the enlargement. In order to do this, the light is allowed to act on the whole picture as long as is necessary to print fully the dark tones. Then a piece of cardboard is held in such a position between the lens and the

paper that it prevents the light from reaching and consequently overprinting the part of the picture that has been fully recorded without preventing it reaching the parts that are not yet fully printed.

Toning

In the earlier printing processes used by photographers—those in which the image was obtained by the continued action of light and which were toned by the deposition of gold from a toning bath—the prints obtained were in various shades of purple and brown, and these shades became so associated with photographs in the mind of the public that when the black and white prints made on Velox and bromide papers began to displace the earlier Solio and Aristotype prints, the general public would scarcely recognize them as "photographs" at all, and a demand soon arose for some method of toning the black images of bromide and Velox prints to a brown or sepia similar to that of the gold-toned printing-out papers.

It seems to be characteristic of mankind to want what they have not got, and it is interesting to note that with the earlier printing-out processes which easily gave warm tones, chemists were anxiously working to get methods of obtaining black and white prints, while with the developing-out processes, which naturally give good black and white prints, photographers desire to obtain warm sepia and brown tones.

The processes for obtaining sepia prints from the black developed-out images all depend on one chemical reaction; namely, that by which silver bromide is converted into silver sulfide. Silver sulfide is a dark colored, almost black, substance well known to the housekeeper—if not by name—as the tarnish which appears on silverware after it has been some time in the air, the surface of metallic silver being attacked by sulfur compounds in the air, which generally come from the products of combustion of gas in the cooking range or from coal heating devices.

Now, when any chemical substance *can* be produced by the interaction of two other chemical substances in solution the question as to whether it *will* be produced depends upon whether it is more or less soluble than the substances which can form it. Silver sulfide is less soluble than silver bromide so that when silver bromide is treated with a solution containing sulfur in a free form it is changed into silver sulfide and the silver sulfide is deposited in its place. On the other hand, metallic silver, such as that which forms the image in a developed print, is less soluble than silver sulfide and consequently we cannot change it into silver sulfide by simply treating it with a solution containing free sulfur, but if in this solution we have some substance which will dissolve metallic silver, then we can change the metallic silver itself into silver sulfide. It is on these principles that the sulfur-toning processes are based.

One toning process depends upon changing the silver image of the print back into silver bromide. Now, we know that silver is obtained from silver bromide by reduction, just as iron is obtained from iron ore, and therefore we can get back silver bromide from silver by oxidation, which is the reverse process to reduction. If we use any solution which will oxidize silver and have potassium bromide present in the solution, the silver image will be turned into silver bromide.

The usual way to do this is to treat the black print after fixing and washing with a solution containing potassium ferricyanide, which is an oxidizing agent, and potassium bromide and this turns the black silver image into a yellowish white image of silver bromide which is scarcely visible, so that the process is called "bleaching" since the black silver turns into white silver bromide, and then after washing, this silver bromide is treated with a solution of sodium sulfide, which turns it into the brown silver sulfide which gives us our sepia-toned print. So, to make a sepia Velox print by this method, we treated it with the "bleaching solution" which turns the silver into silver bromide, and then "redevelop" this, as it is called, in a solution of sulfide, which converts the silver bromide into silver sulfide and gives us our sepia print.

There is another method of obtaining sulfide-toned prints which is somewhat simpler. We have seen that we cannot turn silver directly into silver sulfide by a solution containing free sulfur unless we have a solvent of silver present in the solution. Now, it so happens that hypo is to some extent a solvent of silver, and also that with a weak acid, hypo gives free sulfur. Alum behaves chemically like a weak acid and it also has the valuable property of hardening the print, so if we put the print which we wish to tone into a solution containing hypo and alum, the silver will slowly be changed into silver sulfide and the print will be toned brown. This change goes on very slowly at ordinary temperatures, but by heating the solution it goes much more rapidly, so that if we heat a bromide or Velox print in a solution containing hypo and alum, we shall get a good sepia tone at the end of ten or twenty minutes without any further difficulty, the only objection being that the bath, like all baths containing free sulfur, and like the sodium sulfide used for redeveloping in the other toning process, smells rather unpleasantly.

Equally good results in sepia toning cannot be obtained with all papers, but a great deal depends on the development of the print. To get good sepias, development should be full; an under-developed print will always give weak, yellowish tones when compared with one in which development has been carried out thoroughly, which will give a strong, pure sepia. It is important to remember this, as two prints which may look alike as black and white prints will tone differently if they have not been developed to the same extent.

A DANCE OF CARBON PARTICLES

HOWARD JAMES,* BOULDER, COLORADO

Fine particles of pure carbon, suspended in a drop of suitable alkaline medium which is surrounded by an olive oil-gasoline solution, exhibit a rapid, whirling motion in their little droplet world. Meanwhile, the drop itself undergoes frequent changes of shape and position.

The oil solution is prepared by dissolving 10 cc. pure olive oil in 20 cc. high-grade gasoline. A beaker of 50 cc. capacity, or a small jelly glass, serves as a container. The alkaline medium is a fourteen per cent aqueous solution of sodium hydroxide to which a little gum arabic and sodium carbonate have been added. Particles of carbon are suspended in this solution by adding to it a drop of Higgin's Eternal Carbon ink.

A drop or two of the caustic is added to the oil by means of a medicine dropper held so that the tip is level with the rim of the container. The drop shatters as it strikes the bottom of the container, and a tough, transparent skin forms around each individual droplet. The carbon particles, which are large enough to be plainly visible to the unaided eye, soon acquire a whirling motion within their droplets. The drop itself moves restlessly around the bottom of the container. The larger droplets sometimes develop volcano-like fissures, and divide at such points to form two droplets. The dance of the carbon particles continues meanwhile for a quarter of an hour. There are probably several forces at work in this case. The shattering of the drop at the end of its fall would impart some motion to the particles. There must, however, be forces at work which keep the particles in motion for the length of time given. Indeed, the motion is accelerated for a minute or two after the drop has reached the bottom of the container. That Brownian movements do not contribute essentially is evident from the fact that the particles lose by far the greater part of their activity after a definite period of time has elapsed.

Osmosis is probably an important factor. If the film which surrounds the drop is semi-permeable, the tendency would be for some osmotic pressure to be set up between the two solutions. The pressure thus generated is sometimes relieved by the formation of fissures. Since many of the drops, however, do not form fissures and do not expand appreciably, it is evident that in some way the entrance of molecules from outside the drop is compensated for by a corresponding exit of molecules from within the drop. Hence, the film surrounding the drop is not semi-permeable to a high degree.

A somewhat similar case yields a different set of phenomena. The results of this experiment, however, are often unsatisfactory. The gasoline solution is replaced by a one-to-three solution of castor oil in denatured alcohol. This is placed in a small, round-bottomed container, such as the

* Winner of ten-dollar award in undergraduate contest closing March 15th.

bottom of a test tube. Two or three drops of caustic (which contain no carbon, but may contain suitable coloring matter) are added with a dropper. As the drops will combine at the bottom of the container, it is advisable to shatter the large drop formed by forcing air into it by means of the medicine dropper. Some of the newly formed drops send out streamers, which spread out into wriggling snakes as they reach the surface of the oil. Others grow and divide in a manner which reminds one of the amoeba.

In this case, both solvents used (water and alcohol) are completely miscible in one another, and this fact probably is an important factor in this case. Indeed, though the droplets become larger, their shapes become less and less clearly defined, until they finally disappear altogether.

The Sugar Industry. The world's sugar industry was the subject of the Streatfield Memorial Lecture delivered at the Institute of Chemistry by Mr. Lewis Eynon, on Nov. 22, 1929, and recently published. Sugar cane, which until about 130 years ago, was the only source of sugar, was known before the Christian era, and is supposed to have originated in India. Arabs and Egyptians, however, were the pioneers in the art of crystallizing sugar many centuries later. Sugar appears to have been first imported into England from the Mediterranean countries in the fourteenth century, and the art of refining introduced during the reign of Henry VIII. During the seventeenth and eighteenth centuries, however, the bulk of the world's sugar was derived from America and the West Indies, where abundant slave labor and good growing conditions particularly favored the industry.

Attempts to produce sugar from sources other than cane were first made in Europe during the Napoleonic Wars, when the possibilities of utilizing grapes and beetroot were investigated, but without much success in the former case. With the exception of France, where the industry obtained government support, it was short-lived, and did not become general in Europe until 1860.

Despite the development of the beet-sugar industry, the importation of cane sugar into Europe continued to increase for some time, and although during the latter part of the nineteenth century the cane sugar industry suffered temporarily from severe competition, the markets gradually adjusted themselves, and in 1901–02 cane and beet each contributed about 50 per cent of the world's production of sugar. Sugar-beet growing was first attempted in England seventy years ago; but the industry developed little until the raising of the subsidy in 1925.

Besides the cane- and beet-sugar industries, the production of glucose from starch, first discovered in 1811, is an important manufacture. Improved methods, the discovery of new sources of sugar, and the extension of the industry into temperate climates have enormously increased the world's supply of sugar.

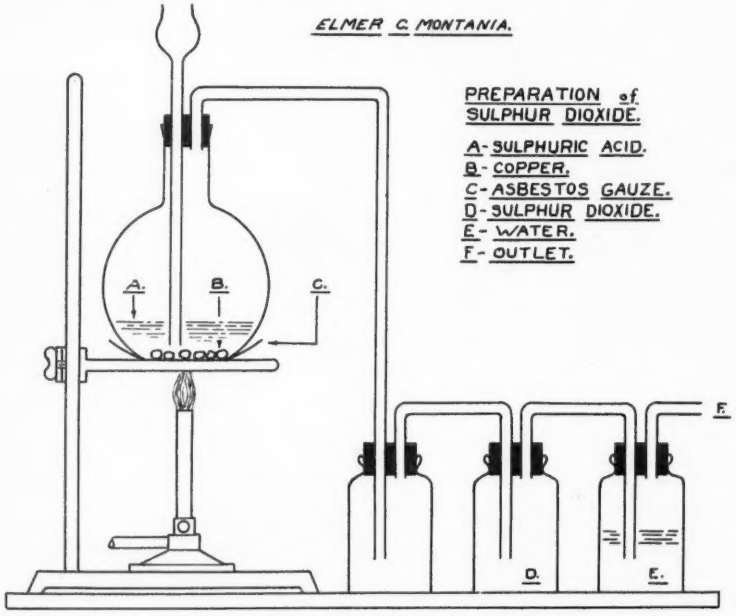
Although sugar, at one time a luxury, has now become an important article of food, human consumption is not likely to increase at the same rate as the supply, and it seems that a new use for sugar must be found, or further growth of the industry will be impossible. The production of power alcohol from sugar seems to be the solution of the problem, and it would also provide a useful substitute for petrol before the world's store of this is exhausted. The future prosperity of the sugar industry would thus seem assured.—*Nature* (London)

WINNERS IN SEVENTH "WHAT IS WRONG?" CONTEST

The seventh contest called forth the largest number of contributions yet received. We are happy to report that many of the papers and drawings were good.

The criticism of Elmer C. Montania of Milwaukee, Wisconsin, winner of the five-dollar award, follows:

The ring stand, as was shown in the drawing, was not drawn in proportion with the rest of the apparatus. There were also lines drawn through the gas hose, thistle tube, flask, and the mouth of the bottle containing sulfuric acid. The delivery tube of the second bottle was also shown closed, thereby preventing any air from escaping.



The drawing did not show a rubber stopper in the flask; therefore, all of the sulfur dioxide generated would pass off into the atmosphere. Because sulfur dioxide produces a choking, irritating sensation in the throat, it is undesirable to have it pass off into the room where one is working.

There was no opening shown in the second bottle to permit the air to escape; therefore, if there were a stopper in the flask the apparatus would be air-bound.

The drawing had shown both delivery and outlet tubes extending quite far into the bottle; since sulfur dioxide is heavier than air it settles to the bottom of the bottle. The only air forced out will be the small amount between the bottom of the bottle and the bottom of the tubes; this makes it impossible for one to get a full bottle of pure sulfur dioxide. The bottle should be connected in this manner: the delivery tube is to extend fairly well into the bottle, while the outlet tube extends just beyond the stopper. This permits the sulfur dioxide to displace the air.

The thistle tube shown in the drawing played no part in the experiment, since the demonstrator was pouring the acid into the flask by means of a glass stirring rod. The sulfuric acid should be administered through the thistle tube. The end of this tube must be submerged in the solution; if the tube is not, the sulfur dioxide generated will pass out through it.

In the drawing the flask with a round bottom was shown placed in a bowl of water; therefore, it would tend to tip easily, because it was not supported by a clamp.

When copper reacts with hot concentrated sulfuric acid; copper sulfate, water, and sulfur dioxide are formed. The rate at which sulfur dioxide is generated depends greatly upon the temperature of the reacting solution. A fairly good reaction is obtained above the boiling point of water. It is impossible to obtain a temperature higher than 100°C., as long as the flask is indirectly heated through a bowl of water. When water boils the action is vigorous. If this temperature is retained the flask, which was not shown clamped, would be broken by the constant bobbing up and down produced by the violent action of the water. Should the flask be broken, the hot concentrated sulfuric acid coming in contact with the hot water, would spatter. The bowl of water, therefore, is impractical in this experiment. There should also have been a piece of asbestos gauze beneath the bowl to prevent the flame from coming in direct contact with the glass, thus preventing any possibility of its cracking. For the reasons stated above one concludes that a flask resting on asbestos gauze would prove to be a better method than the one shown in the drawing. In the suggested method a low flame should be applied to the reacting solution to prevent the sulfuric acid from reaching its boiling point. When sulfuric acid boils it decomposes into water and sulfur trioxide, which is not desired.

There should be three bottles used in performing this experiment, the first to collect all water vapor which passes over into it from the generator, the second to collect pure sulfur dioxide, and the third, containing water, as a medium for eliminating the air and preventing the sulfur dioxide from passing into the atmosphere. In each case the bottles should be connected thus; the delivery tube is to extend fairly well into the bottle, while the outlet tube is to extend just beyond the stopper.

In the first bottle ample room should be provided between the bottom of the bottle and the bottom of the delivery tube, to prevent the condensed water from being drawn back into the generator, while it is cooling. The delivery tube of the third bottle is to extend into the water, while the outlet tube of this bottle is merely an opening into the atmosphere, to permit the air to escape.

At standard conditions 79.789 volumes of sulfur dioxide will dissolve in one volume of water; therefore, as the air ceases to bubble through the water in the third bottle one knows that the sulfur dioxide has forced out all of the air, and the excess sulfur dioxide is being dissolved in the water.

The set-up depicted by Mr. Montania might be somewhat improved, we believe, by providing for flexibility and ease of disconnection in the connecting tubing.

Winners of one-dollar awards were: Francis Kinkel, Kirkwood, Missouri; O. J. Wenburg, Oberlin, Ohio; R. M. Lewis, New Canaan, Connecticut; Letitia Yoakam, Providence, Rhode Island; Elvira Hernández, El Paso, Texas.

The world is daily increasing in experimental knowledge, and let no man flatter the age with pretending we have arrived at a perfection of our discoveries.—BENJAMIN FRANKLIN

THE LIBRARY

POPULAR SCIENCE MONTHLY, *May, 1930*

(*P. 19.*) "Where America Gets Its Booze." An interview with *Dr. James M. Doran* by *E. E. Free.* Providing America with alcoholic drink is now a well-organized business with an income estimated at over three billion dollars a year. Alcohol for the bootleg trade is now made, thousands of gallons at a time, in great fermenting vats and modern rectifying stills. The basis of the new industry is corn sugar. Most of the liquor sold today is synthetic—that is, made from alcohol, water, and flavoring extracts. However, much pre-prohibition whiskey and practically all pre-prohibition gin were made in precisely the same way. Little denatured alcohol is now "re-cooked" for the bootleg trade. The process of purification is too expensive as compared with the fermentation of corn sugar and distillation of the resultant "mash." (*Illustrated.*)

(*P. 27.*) "Oil Makes the World Go Round." *George Lee Dowd, Jr.* The author discusses the theory of lubrication briefly. He then takes up lubricants and their uses and discusses odd lubricating jobs and some at present unexplained phenomena of lubrication. (*Illustrated.*)

(*P. 29.*) "War Gas Aids Fight on Worms in Church." The woodwork of a fifteenth-century church in Linz, Austria, is being honeycombed by worms. Recently the church was sealed, filled with poison gas, and left for a week. The success of the treatment has not yet been definitely ascertained.

(*P. 30.*) "Poison Tested on Insects to Show Fatal Dose." Leaves coated with known amounts of poison are fed to insects. The amount of poison ingested is estimated by weighing the leaf before and after feeding. By varying the amounts which the insects are allowed to eat the minimum lethal dose is determined.

(*P. 30.*) "Turn of Switch Makes Powerful Antiseptic." Dakin's solution, a very useful antiseptic but an unstable one, is now produced as needed in a special electrolytic cell designed in the chemical engineering laboratories of Iowa State College. The electrolyte is sodium chloride. The active principle of the disinfectant is sodium hypochlorite.

(*P. 34.*) "Water Blister Fluid Cures Drug Addicts." An accidental discovery in an Egyptian hospital indicates that injection of fluid from blisters such as are raised by a mustard plaster may be a cure for drug addiction. Further tests are planned.

(*P. 36.*) "Insulator and Conductor in One Substance." "Thyrite," a composition developed by the General Electric Company, seems to be an ideal material for safeguarding electrical transmission lines from lightning. Toward currents of comparatively low voltage, such as those conveyed by the transmission lines, the composition acts as an insulator. High voltage discharges, such as those set up by lightning, are harmlessly conducted to the ground.

(*P. 38.*) "Treated with Health-Rays, Ice Cream Cures Rickets." A new addition to the list of ultra-violet-irradiated foodstuffs.

(*P. 45.*) "Found—'87,' One of Two Missing Elements." Dr. Fred Allison and Prof. E. J. Murphy, of the Alabama Polytechnic Institute, announce the discovery of element 87, sometimes called "ekacaesium," in samples of ore from Maine. The element has not been isolated, however.

(*P. 45.*) "Aluminum Best Reflector for 'Sunshine' Lamps." According to the U. S. Bureau of Standards, polished aluminum reflects nearly 50 per cent of ultra-violet rays incident upon it. This is a comparatively high percentage of reflection.

(*P. 50.*) "Film Developed for Movie Finds Carbon in Sun." A neocyanin-sensitized film developed for the moving picture industry records deep red and infra-red rays. Photographs of the sun's spectrum recorded on neocyanin plates reveal infra-red lines characteristic of carbon.

(*P. 50.*) "New Test Shows Spinach May Contain Vitamin A." A recently devised spectroanalytic test for vitamin A seems to indicate the presence of the vitamin in spinach juice.

(*P. 51.*) "The Art of Chromium Plating in Pictures." The title is self-explanatory. Five photographs showing actual plant operations are presented.

(*P. 55.*) "Sugar from Sunflowers." *Robert E. Martin.* The U. S. Bureau of Standards is completing a plant which will extract three quarters of a ton of levulose a day from Jerusalem artichoke tubers. Levulose, commonly called fruit sugar, is the sweetening agency in fruits and in honey. It is 50 to 75 per cent sweeter than cane sugar and more readily digestible. It is a permissible sweetening for diabetics. The Jerusalem artichoke is misnamed—it is actually a native American plant of the sunflower family. The present experiments may point the way to cheap levulose for the American table and to a new and profitable farm crop. (*Illustrated.*)

(*P. 61.*) "New Baking Powder Leaves No Residue." Acetone dicarboxylic acid decomposes into volatile products only.

(*P. 62.*) "Tannin Still in Chestnut Long After Tree Dies." Chestnut trees killed by blight are found to retain their tannin content for as long as twenty or twenty-five years, though they soon lose both bark and sapwood.

(*P. 63.*) "More Tin in Bells, Less Din in Cities." According to a British metal expert, the addition of about 25 per cent of tin to the bronzes from which bells and whistles are made would result in more melodious signals and in less noise-wracked nerves for the general public.

(*P. 92.*) "How to Test Brass and Bronze." *W. H. Hammond.* Chemical tests for six general classes of brasses and bronzes commonly used by mechanics.

(*P. 112.*) "Home Workshop Chemistry." Notes on the finishing of

small metal, wood, and cardboard articles with lacquer, boiled linseed oil, and glue.

SCIENTIFIC AMERICAN, *May, 1930*

(*P. 350.*) "Revising Our Air and Our Water." *Henry Norris Russell.* Spectroscopy has had a new field opened to it by means of the recent perfection of photographic plates which are highly sensitive to deep red and infra-red rays. The sensitizing agent is "neocyanin," a dye developed by the Eastman Kodak Company to meet the demands of the motion picture industry for a film which would make possible the shooting of "night" scenes in daylight with the aid of light filters. The author discusses briefly the origin and significance of line and band spectra and tells of the discovery of isotopes, particularly the recent discovery of an isotope of oxygen. (*Illustrated.*)

(*P. 355.*) "Florida's Lusty Infant Industry." The tung-oil tree, a native of China, has been successfully introduced into Florida. Breeding and culture experiments have resulted in a much more productive tree than the best the Chinese ever had. Tung oil has peculiar properties which make it superior to linseed oil for many purposes. It appears that tung-oil nuts can be raised and extracted much more economically than flax seed. (*Illustrated.*)

(*P. 360.*) "Blasting Coal without Explosives." *Frank H. Kneeland.* In mining coal, where a high proportion of lump sizes and a minimum of slack are desirable a "slow" explosive for blasting is indicated. For this reason black powder has always been the principal explosive of the coal miner. A new blasting device which has the virtues of black powder in even greater degree and which has the further advantage of operating without the emission of flame or the evolution of noxious gases has been perfected. The device, known as Cardox, is a cylinder loaded with liquid carbon dioxide. The cylinder has one end plate which will give way at a predetermined pressure. The pressure is built up by gasifying and heating the CO_2 by means of an electrically ignited chemical heating mixture within the cylinder. When released the expanding gas tears loose and throws down the coal. (*Illustrated.*)

(*P. 376.*) "Michelson." *William H. Crew.* Professor Michelson, first American to receive the Nobel prize in physics, was educated at the U. S. Naval Academy and pursued post-graduate studies at Berlin, Heidelberg, and Paris. He later returned to the Naval Academy as an instructor and there made his first determination of the velocity of light. Professor Michelson has devised the interferometer, has made repeated and increasingly accurate determinations of the velocity of light, has performed a series of experiments designed to detect a possible ether-drift, and has established a permanent standard for the meter in terms of the wave-length

of a red line in the cadmium spectrum. He is projecting still other experiments. (*Illustrated.*)

(*P. 380.*) "Our Air Analyzed." An account of experimental methods for the study of smoke and dust pollution in the atmosphere in industrial and metropolitan areas. (*Illustrated.*)

(*P. 384.*) "Edison's Rubber." *G. H. Dacy.* An account of Thomas A. Edison's Florida experiments which will, it is hoped, lead to the discovery of a plant or plants capable of producing emergency supplies of rubber when ordinary sources are cut off by war or other causes. Henry Ford and Harvey S. Firestone are coöperating in these experiments. (*Illustrated.*)

(*P. 393.*) "Zinc Treatment Kills Weed Seeds without Injuring Sprouting Trees." The United States Forest Service has found that a great saving in labor and a considerable saving in mechanical injury is effected in nursery seed beds by chemical weed destruction. One and one-eighth ounces of zinc sulfate are dissolved in one quart of water and distributed over four square feet of seedbed.

(*P. 393.*) "Huge Steel Balls to Carry Helium." Steel balls are being adopted for helium transportation instead of the cylindrical tanks formerly used. The new containers are capable of withstanding much higher pressures and hence will carry a greater load.

(*P. 396 et seq.*) "Chemistry in Industry." Includes the following items: "Spray Drying of Latex Revolutionizes Rubber Manufacture." "Roast Beef in a Salt Shaker." Monosodium glutamate, a synthetic chemical, imparts a meat-like flavor to foods. It is a much-used condiment in Oriental countries where the diet is chiefly vegetable. "How to Flame-Proof Fabric." Several processes tested by the British Fire Prevention Committee are described. "Where Does the Bootlegger Get His Alcohol?" The conversion of corn sugar into illicit alcohol is now a large-scale industrial operation. "Two Gases Make Fertilizer." A German process combines SO_2 directly with gas-plant ammonia in the vapor phase, precipitating solid NH_4SO_4. The use of dilute sulfuric acid is eliminated and costs are greatly reduced. "Chemicals Do Not Fool Chickens." The U. S. Department of Agriculture warns that no known drug or combination of drugs when fed to poultry will increase egg production. "Enzyme in Bleaching Flour." Until recently the bleaching of flour has been accomplished by means of rather powerful oxidizing agents. The latest development is a preparation which has as its active principle an enzyme capable of destroying or decolorizing the natural carotinoid pigment of flour. "New Plastic Material from Cornstalks." The difficulty of converting cornstalks into paper lies chiefly in the tendency of the cornstalk cellulose to hydrate. This tendency has been turned to account in the development of a new plastic—"Maizolith." "Russian Chewing Gum

Proves to Be Rubber." A Russian plant having a larval parasite producing cocoons of a rubber-like substance used by the natives as a sort of chewing gum has been found to contain rubber.

(*P. 403.*) "Ford Adopts New Alloy." The "rustless steel" trim of the new model A Ford is made from an alloy known as Allegheny metal. It consists of refined steel combined with about 18 per cent of chromium, 8 per cent of nickel, and smaller proportions of carbon, manganese, silicon, phosphorus, and sulfur. The method of compounding is quite as important as the composition.

SCIENCE AND INVENTION, *May, 1930*

(*P. 24.*) "Feed Your Plants with Chemicals." *Raymond B. Wailes.* A well-balanced fertilizer for house plants and garden flowers can be made by mixing $1^1/_2$ lb. sodium nitrate, 1 lb. tertiary sodium phosphate, 1 lb. potassium sulfate. For liquid fertilizer dissolve a rounded tablespoonful of the above mixture in a gallon of water. The author discusses fertilizers and fertilizing. (*Illustrated.*)

(*P. 32.*) "Foods That Fight Your Stomach." *Frederick Damrau.* The author discusses protein sensitivity, diagnostic tests, and remedial measures.

(*P. 34.*) "Alcohol, Not Frost, Colors Autumn Leaves." According to Samuel G. Hibbon, of the Westinghouse Lamp Co., the coloring of autumn leaves is due to a stage in the maturity of the foliage which is accompanied by an alcoholic fermentation, and not to frost as commonly thought.

(*P. 37.*) "Hardening Copper—A Lost Art?" The hardening of copper is not a lost art. We can produce hardened coppers superior to any that the ancients knew.

(*P. 38.*) "Gold Stronger than Steel." According to Professor R. C. Brumfield, gold alloys three times as strong as bridge steel have been developed at the Cooper Union Institute in New York. The announcement follows the results of three years of research in the field of dental gold, during which nearly 60 new gold alloys were investigated.

(*P. 44.*) "Low Vacuum Pump." *Howard Dietrich.* Diagram and description.

(*P. 89.*) "Home Made Gas." *Don Bennett.* A description, with diagram, of the "Gasolier"—a home device for manufacturing fuel or lighting gas from gasoline.

(*P. 95.*) "The Gold Mine of Chemistry." *Alfred M. Caddell.* The financial editor traces the results of research in the earnings of various well-known corporations.

POPULAR MECHANICS, *May, 1930*

(*P. 711.*) "New Phonograph Disk Has Long Life." From a by-product of the coal-tar industry Germany has produced a phonograph-

record disk that is flexible, unbreakable, and fire and waterproof. It is very thin and light, as well as long-wearing.

(*P. 717.*) "Mystery Lake of Solid Salt at End of Five Rivers." Lake Eyre in Australia, about which superstitious bushmen for many years have told tales of mystery and evil, has been found by a party of visiting scientists to consist of a vast expanse of solid salt, more than 100 miles long and over fifty miles wide, and so thick that a heavy truck can be driven over the surface.

(*P. 717.*) "Radium in Georgia Mountain." Waters from springs originating in Stone Mountain are found to be highly radioactive. Neither the amount of radium in the mountain nor its availability has been estimated.

(*P. 724.*) "Bank Notes Coated with Tin Will Not Tear or Burn." The metal is fused and applied to the pulp by means of a suitable atomizer. No heat injury to the fiber results.

(*P. 725.*) "Desert May Furnish Dry Ice." The commercial possibilities of "dry ice" from carbon dioxide wells lying beneath the arid stretches of western Colorado and eastern Utah are being stressed by the Department of the Interior.

(*P. 790.*) "Unknown Element Is Found in Two Minerals." Element 87 has been detected in two well-known minerals—lepidolite, a form of mica, and pollucite. The element has not yet been isolated.

(*P. 800.*) "Dyes for Detection of Germs to Be Standardized." A special commission is working upon the standardization of biological stains.

(*P. 809.*) "Silk from the Air." It has been found possible, though not practical, to synthesize sugar from CO_2 and H_2O. Dr. Herbert Levinstein suggests that we may eventually synthesize cellulose from the CO_2 and water vapor of the atmosphere. Cellulose is, of course, the basis for "artificial silk."

Autumn-Colored Leaves Millions of Years Old. Leaves millions of years old which still hold all the colors of autumn have recently been found in the newly discovered fossil leaf beds of Wheeler County, central Oregon, by Dr. Ralph W. Chaney, paleobotanist of the Carnegie Institution of Washington. The perfect preservation of the coloring in the leaf impressions is attributed to minerals in the matrix. The fossil flora found in the region is millions of years older than was first surmised, Dr. Chaney says, and probably will throw interesting light on numerous extinct plant species that formed a semitropical jungle in the Mitchell area of primeval Oregon.

Dr. Chaney found in volcanic shale an intact leaf, bearing virtually the appearance it did when it fell from a jungle tree millions of years ago. This leaf was carefully sealed in its matrix, and will be sent to the University of California at Berkeley.

The plant horizon is just above the beds of the cretaceous seas which swept over ancient Oregon, leaving an abundance of marine fossil in the Mitchell area.—*Science Service*

Chemical Digest

THE GROWING IMPORTANCE OF FREQUENCY*

The relation between energy and mass, $e = mc^2$, where c is numerically the velocity of light, indicates that energy has mass and that mass has energy; furthermore, it suggests that the conservation of mass of the chemists is at one with the conservation of energy of the physicists. This relation appears more emphatic if we so alter the unit, either of mass or of energy, that the constant c^2 becomes superfluous, and we write in consequence $E = M$. This would be correct, for example, if our new unit of energy were 9×10^{20} ergs. We do not therefore state that energy is necessarily matter, but we do state that the same abstract number will express matter in terms of energy, or energy in terms of mass. We must always be careful not to confuse, say, sheep and oxen, because we happen to see the same number of these different animals.

It is remarkable that transfers of energy take place in quanta of value hf, where f is frequency and h is Planck's constant. We can again alter our unit of energy, or our unit of time, in such a manner that h is superfluous, and the relation $e = hf$ becomes $E = F$, and this indicates that energy and frequency can be expressed by the same abstract number, so that a *conservation of energy has its counterpart in a conservation of frequency*. Thus in place of the linkages of Nature, to which we are growing accustomed, such as

$$e = mc^2 = hf = Jq,$$

we can, by adopting what I venture to call super-units, write down

$$E = M = F = Q,$$

wherein energy, mass, frequency, and heat appear all expressed with the same abstract number. We are not unfamiliar with this. Energy is expressed sometimes in ergs, at other times in equivalent calories, or even in volt-electrons.

It is the purpose of this note to urge a status for frequency comparable with that of its older brethren; if, indeed, we are not recalling the music of the spheres to a fresh harmony.

Again, the Einstein-Bohr equation

$$h\nu = W_1 - W_2$$

can be written

$$h\nu = hf_1 - hf_2,$$

or more simply

$$\nu = f_1 - f_2,$$

which expresses clearly the beat or heterodyne character of the observable frequency ν derived from two unobserved or unobservable frequencies f_1, f_2 characteristic of the atom, due to the necessity of standing waves or "repeat patterns" of the electronic waves in their passage around the nucleus.

So, too, the Einstein transformation equation

$$T = (t - vx/c^2)/\sqrt{1 - v^2/c^2}$$

may refer to a particle moving with velocity v relatively to an observer. Now this

* Correspondence of A. S. Eve, McGill University, Montreal, Canada, to *Nature*, **125**, 454–5 (Mar. 22, 1930).

equation, as de Broglie pointed out, involves another velocity u, which may be denoted by c^2/v and is greater than the velocity of light.

It may be thought of as a phase velocity, of which v may be shown to be the group velocity. In the case of a mass m, moving with velocity v, if we state

$$\begin{aligned} h\nu &= mc^2 \\ c^2 &= u\nu \\ u &= \lambda\nu \end{aligned}$$

and multiply the left sides together, and the right sides, and equate, we have after canceling

$$\lambda = h/mv.$$

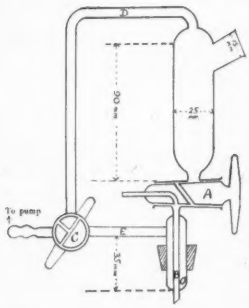
This is the precise relation which Davisson and Germer, and G. P. Thomson, have shown to hold for an electron. Thus the frequencies of waves seem to be achieving a remarkably fundamental rôle, comparable with that of energy. Waves of what? The key to the central tower of physics has yet to be found. No less obscure is the connection between the two different types of electric charge and their attendant waves. The linkage between energy and time, which resembles that between p and q in Dirac's equations, also suggests a close relationship between energy and frequency.

Historical Apparatus of Rayleigh, Discoverer of Argon, Threatened by Fire. Sincere regret will be felt throughout the world of science at the destruction by fire of a large part of Lord Rayleigh's laboratory at Terling Place, Chelmsford, Essex, on March 7th. After taking his degree at Cambridge in 1865, the late Lord Rayleigh found great difficulty in getting opportunities for experimental research or instruction in laboratory work. Three years later he started experiments on his own account at Terling Place, and from there produced a number of papers which at once secured for him a position as a leader in physical science. When he resigned from the chair of experimental physics at Cambridge in 1884, he continued his researches in his private laboratory, and it was there that he carried out the precise determinations of the density of nitrogen which led to the discovery of argon. The simplicity of the apparatus used by the late Lord Rayleigh is well known, and most visitors to the laboratory were astonished that results of prime significance could be obtained with such modest equipment. We are glad to know that most of his historic apparatus has been saved as well as all of his books and papers.

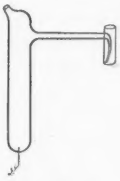
The upper story of the laboratory at Terling Place—originally a stall loft—has been burnt out; it was here that the main work on argon was done. Among the pieces of historic apparatus which have been destroyed are the original Rayleigh refractometer and the manometer used for adjusting the pressures of gases to an accurate standard in the weighings of nitrogen, hydrogen, and oxygen. Most of the present Lord Rayleigh's chief working instruments have also been destroyed and much preparatory work for experiments in progress is gone. The apparatus thus lost includes several valuable spectrographs, quartz apparatus, and lenses for investigating the optical properties of mercury vapor, air pumps, equipment for measuring the light of the night sky by photoelectric cells, and other instruments used in recent or current researches. It is distressing to have to record a disaster of this kind, and we ask Lord Rayleigh to accept the sincere sympathy of scientific workers everywhere at the losses he has suffered and the consequent interference with his research work.— *Nature* (London)

ABSTRACTS

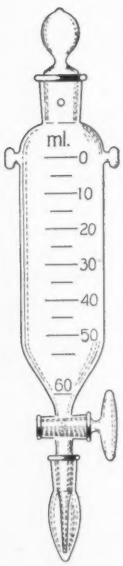
APPARATUS, LABORATORY PRACTICE, AND DEMONSTRATIONS



An Improved Receiver for Vacuum Distillation. G. A. R. KON, JR. *J. Chem. Soc.* (London), Jan., **1930,** 182.—It is cheaper and simpler than the ordinary "Perkin Triangle," as it has only two taps instead of three. Another advantage is that when air is admitted to the lower portion of the apparatus in order that the receiving flask may be changed, the last few drops of distillate are blown into the receiving vessel, thus minimizing waste. J. W. H.



An Improved Calomel Electrode Vessel. S. E. HILL. *Science,* **71,** 193 (Feb. 14, 1930).—In previous work th salt bridge connecting cell and electrode has been a cotton string wet with KCl solution. Perfect insulation was doubtful. An electrode vessel of the type illustrated has been perfected. The cup into which the string dips is blown onto the end of the electrode arm, which is long enough to permit placing the cups as close together as desired. Insulation is complete. G. H. W.



An Improved Weight Buret. H. B. FRIEDMAN AND V. K. LAMER. *Ind. Eng. Chem., Anal. Ed.,* **2,** 54 (Jan., 1930).—The authors recommend a weight buret of the type shown in the diagram as offering advantages over the usual type. A weight buret offers several advantages over the volume buret; the ability to weigh to more significant figures, absence of errors in drainage and reading the meniscus, and the fact that it need not be calibrated. D. C. L.

Multiple Melting-Point Apparatus. O. L. BARIL. *Hormone,* **4,** 70–1 (Mar., 1930).—The arrangement shown in the diagram is

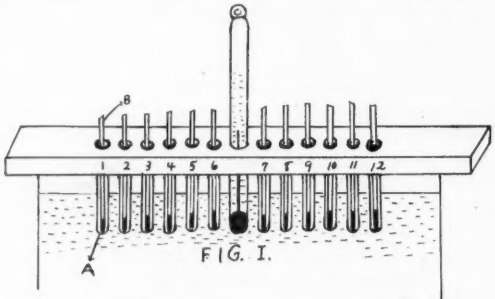


FIG. I.

FIG. II.

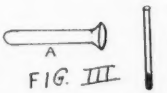


FIG. III

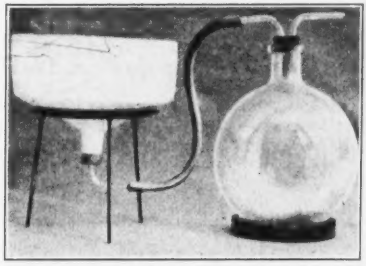
an aid in rapidly determining the approximate melting points of organic compounds as a preliminary to determining the true melting point. The holder is a paraffined board, and the bath is sulfuric acid in a 400-cc. beaker.

The same apparatus for determining the true melting point is described in *Hormone,* **4,** 117 (Apr., 1930). H. H. K.

A Simple and Inexpensive Refractometer. E. E. JELLEY. *J. Sci. Instruments,* **7,** 14–9 (Jan., 1930).—A simple refractometer which may be built up from easily obtainable and inexpensive components is described. The accuracy of this instrument

is to the third decimal place, and when care is taken to keep the temperature under control the accuracy is raised to two or three units in the fourth decimal place. R. L. H.

Novel Filtration Aids. *Syn. Org. Chem.*, **3**, No. 4 (Apr., 1930).—Using a cut-off Buchner funnel and suction arrangement, the apparatus is less cumbersome than the usual arrangement.



Another method is to lower the funnel into the suspension to be filtered when a large amount of liquid is to be removed; or for fibrous, bulky materials a dental rubber dam may be used to press the liquid from the product. H. H. K.

A Projection Model to Illustrate the Passage of an Alpha Particle in the Neighborhood of an Atomic Nucleus. E. N. DA C. ANDRADE. *J. Sci. Instruments*, **7**, 94–6 (Mar., 1930).—A small apparatus suitable for projection, by means of which the motion of the alpha particle passing near the nucleus of an atom can be illustrated, is described. This apparatus makes the illustration possible for a large audience to observe the entire procedure. R. L. H.

A Model to Explain the Mechanism of Electrolysis. M. DEK. THOMPSON. *Preprint* **57-9**, *Am. Electrochem. Soc.*, 1930.—A model is described which illustrates the mechanism of electrolysis, showing the following: (1) that there is no change in the middle portion; (2) that the solution remains electrically neutral at the electrodes; (3) that the loss at the anode is proportional to the velocity of the anion. This is done for three different relative velocities of anions and cations. D. C. L.

Anhydrous Magnesium Perchlorate as a Drying Agent. S. LENHER AND G. B. TAYLOR. *Ind. Eng. Chem., Anal. Ed.*, **2**, 58 (Jan., 1930).—The trihydrate has been recommended as a collector of water vapor in combustions because it can be more easily prepared in a suitable physical condition. The trihydrate melts in its water of crystallization at 145°C. and is converted into the anhydrous form at 250°C., forming first a pasty mass not easily reduced to granules. But if heated slowly to 250°C., in a vacuum of 0.1 mm. it does not fuse, and is in a better physical condition for drying gases than the original "dehydrite," while its capacity for water absorption is doubled. D. C. L.

Microscopic Examination of Precipitates as an Aid to Precise Analysis. I. Estimation of Sulfates as Barium Sulfate. S. POPOFF AND E. W. NEUMAN. *Ind. Eng. Chem., Anal. Ed.*, **2**, 45–54 (Jan., 1930).—The results obtained show that theoretical values are procured when the barium sulfate is obtained on adding the sulfate solution to the acidified $BaCl_2$, rather than by the usual order of adding the $BaCl_2$ to the acidified sulfate solution. Photomicrographs show that the crystals produced by adding the sulfate to the acidified $BaCl_2$ are of uniform appearance and differ from those produced in the usual procedure. The uniformity is due to the relatively constant environment that can be maintained by this method. The kind and concentration of metallic ions present affect the analytical results and also the crystalline appearance. The presence of nitrates is objectionable. The chloride contamination is greater in the reverse method, but is just about offset by the solubility of the $BaSO_4$. The following procedure is recommended: to the nearly boiling $BaCl_2$ solution (about 0.1 *M*) containing 4–8 cc. 3 *N* HCl add the sulfate solution dropwise with stirring. Digest for an hour near the boiling point. Wash by decantation and on filter till free from chlorides. Final weight of $BaSO_4$ should be about 0.8 gram, and volume of solution about 350 cc. Gooch crucibles may be used. Heat to 800°C. for 1 hour. If iron is present, filter shortly after precipitation. Numerous photomicrographs are shown. D. C. L.

A Colorimetric Determination of Tin. R. HAUSSEN. *Chem.-Ztg.*, **54**, 143 (Feb. 19, 1930).—The following method is of advantage for the simultaneous determination of stannous and stannic ions. Shake 10 cc. of the solution with a few drops of bromine until the solution becomes pale yellow. Add 5 cc. of a freshly prepared solution of hydrogen sulfide. Let stand for several hours to completely precipitate stannic sulfide and compare colorimetrically with standard solutions that have been prepared in the same way (without the addition of bromine) from solutions of stannic salts of known strength. The value obtained in this way gives the total tin content of the solution. The small amount of sulfur found due to the oxidation of hydrogen sulfide by the slight excess of bromine does not effect the accuracy of the method.

Add 5 cc. of aqueous hydrogen sulfide to 5 cc. of the original solution; let stand and mix with 5 cc. of concentrated hydrochloric acid. Stannous sulfide is dissolved immediately while the stannic sulfide remains and may be determined colorimetrically. The value obtained when multiplied by two gives the content of stannic ion, and the difference of both determinations gives the content of stannous ion. L. S.

The Quality of Commercial Ether. See this title on page 1416.

The Action of Gaseous Chlorine on Metallic Oxides and Silicates. R. WASRUNCHT. *Z. angew. Chem.*, **43**, 98–101 (Feb. 1, 1930); 125–9 (Feb. 8, 1930).—The chlorine gas used was purified by repeated liquefactions. The carbon was heated in vacuum at a temperature of 1800°. It was free from gases and did not change in weight when heated with chlorine to a temperature of 1150° for 3 hours. 0.25 gram of carbon was used. The results obtained are summarized in an accompanying chart. L. S.

Solution of Arsenous and Mercuric Iodide. M. G. ACTON. *Am. J. Pharm.*, **102**, 159–64 (Mar., 1930).—The object of this thesis is an analytical investigation into the chemistry of solution of arsenous and mercuric iodide including the assay and stability. G. O.

Mercury. See **Mercury** and **Organic Compounds of Mercury and Their Products** on page 1421.

Thionyl Chloride. See **Thionyl Chloride in Organic Chemistry** on page 1421.

Modern Methods of Producing High Vacuum and Various Phenomena of Electronic Emission in High Vacuum. E. L. MANNING. *Sch. Sci. & Math.*, **30**, 70–7 (Jan., 1930).—Author lists principal methods for producing low pressures and discusses briefly molecular and condensation type pumps, their characteristics and advantages. Removal of occluded gases, measurements of low pressures, and ionization of gases by an electron stream passing through it are also discussed. B. H. B.

TEACHING OBJECTIVES, METHODS, AND SUGGESTIONS

A Chemistry Study Outline. C. M. HAAG. *Sch. Sci. & Math.*, **30**, 44–5 (Jan., 1930).—Author believes student often is unable to distinguish between the essential and non-essential and needs a definite objective for which to strive, hence submits an outline form for student to fill out with facts concerning most elements and compounds studied in first-year chemistry. B. H. B.

Experiment in Education: An Adventure. R. W. GERARD. *Univ. Chi. Mag.*, **22**, 143–6 (Jan., 1930).—An account of a class in physiology conducted as an experiment on the following basis: (1) No lectures—the three hours per week so scheduled to be devoted to discussion by the class—the instructor to act merely as a rudder. (2) No textbook and no reading assignments; questions raised and interests stimulated in the discussion to be followed up as desired with books and original articles in the library and in the laboratory. (3) No assigned experiments: during the four hours per week allotted to these, the instructor and the assistant to be in the laboratory and the special supply room open, but at all times the laboratory itself to be kept open and the students free to work.

Some difficulties developed but author believes it to have been most interesting and interested class he has ever taught, far more than usual portion of class took an "active" part, class voted almost unanimously to continue course after one month's experience, and expressed opinion that class had learned few facts—but had gained a new idea of science. B. H. B.

An Experiment in Teaching. H. H. WHETZEL. *J. Higher Educ.*, **1**, 125–35 (Mar., 1930).—An outline of Professor Whetzel's method of teaching plant pathology. The student attends lectures when he wishes, asks for a test when he is ready, and decides when his mark will be assigned.

A remarkable plan for stimulating student initiative; used in a class of fifty undergraduates. H. H. K.

Selling Physics and Chemistry. P. M. BAIL. *Sch. Sci. & Math.*, **30**, 195–7 (Feb., 1930).—Report on a poster project designed to answer students' questions: What is physics? Why should I study chemistry? etc. Project was developed gradually—utilizing material of value not only in the classroom but in uniting his outside activities with those of the classroom, and through following steps: (1) recognition of problem and selection of topic; (2) collection of data; (3) organization of ideas; (4) checking reliability of, and selection of data to be used; (5) application—in try-out of material; (6) clinching of facts—(poster made in this step); (7) exhibition of posters.

Cost is stated to be relatively small, and results considered valuable both to students making the posters and in contributing to education of classmates. A sample poster is illustrated. B. H. B.

Poster Projects. See abstract immediately preceding on **Selling Physics and Chemistry,** on page 1414.

Suggested Programs for a Science Club. D. W. MILLER. *Sci. Educ.*, **14,** 331–4 (Nov., 1929).—Suggested activities for science clubs in secondary schools, including an outline of a year's program and a bibliography of sixteen science plays for such clubs. H. H. K.

First Experiments with Talkies in American Schools. W. LEWIN. *Educ. Screen*, **9,** 41–3 (Feb., 1930).—Already some of America's public schools are installing equipment for using talking pictures. Likewise some films for such use are now ready. One of these on "Administrative Departments of the Federal Government" is described in some detail. A list of eighteen industrial sound films is contained in the article. It is suggested that "a happy balance between the verbal and the concrete, between the contemplative and the active phases of life" may well be the ideal of the experimenter with talking pictures for schoolroom use. B. C. H.

A Microcinematographic Apparatus for the Owner of a 16-Mm. Motion Picture Camera. H. ROSENBERGER. *Science*, **71,** 266–7 (Mar. 7, 1930).—An apparatus has been designed for the purpose of making motion pictures of microscopic objects. Any 16-mm. camera, such as Filmo, Ciné Kodak, Victor Ciné Camera, may be used. The construction is the same, but smaller, as found in larger apparatus used for the same purpose. The dimensions given are 24 by 14 by 9 inches. Two sketches accompany the article but no detailed discussion of the machine is given. G. H. W.

KEEPING UP WITH CHEMISTRY

Health in the Chemical Industry. C. O. SAPPINGTON. *Chem. Bull.*, **17,** 84–8 (Mar., 1930).—Recent publications of the National Safety Council list under "Gases and Vapors" and "Skin Affections" over 200 compounds which are injurious to health. The bulk of industrial poisoning is due to lead, benzene, mercury, arsenic, hydrogen sulfide, chromium, carbon monoxide, and carbon disulfide. Skin and eye hazards are two of the most important commonly met.

A report of 2557 companies, including 162 chemical establishments, showed the chemical industries to rank fourth in relative safety, but ninth in favorable accident severity. Within the nine subsections of the chemical industry the most favorable accident frequency rank went to the explosive manufacturer, the most unfavorable to the soap manufacturer. The accident severity list ranked coal-tar distillers most favorably and explosive manufacturers least favorably.

The rubber and petroleum industries have done considerable work on the health hazard in their respective industries. A special committee is at work in the rubber industry, which, by means of questionnaires, obtains much information concerning each compound used as to toxicity, dermatitis, health trouble of any sort including symptoms, and precautions, if any, that must be observed in its use.

In order to deal intelligently with the problem of health hazard, complete studies should be made of the chemical processes used, the susceptibility and adjustment of the employee to the hazard which he meets, the nature of the compounds used, and the ease with which they may be controlled. It should be remembered that the introduction of injurious chemical compounds into the system may take place through the skin, the lungs, and the digestive system. "Although speed and economy of production must be considered, life and health are necessary assets for continuous high standards in quantity and quality of production." H. T. B.

The Relation of the Chemical Industry to Pharmacy. J. C. CARLIU. *Am. J. Pharm.*, **102,** 132–9 (Mar., 1930).—It is very interesting to note the number of chemical products produced by large industrial chemical manufacturers that serve as the starting point or raw materials in pharmaceutical manufacture. Twenty-five years ago pharmaceutical manufacturers produced many of the chemicals required for their own use as well as supplying them to the trade; but this practice has changed somewhat, and today we have many concerns specializing in the manufacture of fine pharmaceutical chemicals while others devote their time to the production of heavy industrial chemicals, both of which find their way into pharmaceutical preparations. On the other hand, it is a well-known fact that many important chemical discoveries were made by pharmacists in the so-called apothecary shops, which discoveries paved the way for many industrial developments. As a further bond of intimate relationship, the writer makes specific mention of some of the products which serve as the raw materials in the manufacture of pharmaceutical products; such as the products of hardwood distillation and the derivatives from coal tar. The article describes in detail the processes involved in the

manufacture of hardwood products as comparatively little has been published of an authentic nature regarding modern hardwood distillation, which has undergone many changes in recent years. In like manner Mr. Carlin tells about the bituminous coal and the coal-tar industry from which many products of pharmaceutical importance are derived. During the World War, as a matter of necessity, pharmaceuticals were manufactured in chemical plants and many chemicals in pharmaceutical laboratories in order to meet the demand. There is a closer bond today than ever before brought about by the close coöperation existing among research workers both in pharmacy and in chemistry. G. O.

Chemical Industries of the South. C. E. MULLIN. *Mfgrs. Record*, Apr., **1930,** *59–62.*—*Chemical industries in the South have grown up mostly since the World War.* Today the South has chemical industries that are about as varied as those of the North. More rayon is produced in Virginia than in any other state. Considerable research is carried on in the South, and most of the research in cotton textile industry is done there. The South has always led in the production of rosin, pine oil, and turpentine. Soaps, sulfonated oils, fertilizers, lime, caustic soda, chlorine, sodium hypochlorite, sulfuric and other acids, ores, alcohol are a few of the products which are turned out in large quantities. R. L. H.

1929 Artificial Silk Production Estimated at Over 400 Million Pounds. *Can. Chem. Met.*, **14,** 40 (Mar., 1930).—Final figures are not available, but the last year's production of artificial silk has been estimated to total over 400,000,000 lb. The latest edition of the "Silks and Rayon Directory" lists 182 firms in this industry distributed as follows: France, 36; England, 24; United States, 20; Germany, 23; Italy, 17; Japan and Belgium, 12 each; Switzerland, 9; Holland and Spain, 12 each; Canada, Austria, Poland, and Russia, 3 each; Greece, Hungary, and Scotland, 2 each; and 1 each in Brazil, Czechoslovakia, and Sweden. R. L. H.

Paper Making. ANON. *Silicate P's & Q's*, **10** (Mar., 1930).—Paper manufacturers find that silicates of soda cut down the time of beating through their ability to increase the speed of hydration and perhaps through their power of dispersing and holding in solution finely divided materials. Silicates of soda also aid in the retention of fillers, elimination of slime, and when used in judicious quantities improve the quality of the paper. Vail, "Soluble Silicates in Industry," The Chemical Catalog Co., 419 Fourth Ave., N. Y., gives a discussion of the effects of silicates on paper. H. T. B.

Cellulose in the Light of the X-Rays. W. BRAGG. *Nature*, **125,** 513–22 (Mar. 1, 1930).—This is a discourse delivered at the Royal Institute on Friday, January 24, 1930, and gives a very interesting and accurate account of the assistance that X-rays have been in the effort to elucidate the constitution of cellulose. F. B. D.

Paints. See abstract of **Protective Coating for Iron and Steel** on p. 1418.

Is Smoke Responsible for Property Damage? R. D. MACLAURIN. *Chem. & Met. Eng.*, **37,** 156–9 (Mar., 1930).—Smoke particles in atmospheric suspension range in size from 0.2 to 1.5 microns, and the aerosol density ranging in density from 0.0001 to 0.0006 grain per cu. ft. in the ordinary city air. The best method of preventing property damage by smoke is to collect it at point of origin, either by bag filtration or by electrical precipitation. R. L. H.

The Facts About Industrial Alcohol. W. N. WATSON. *Chem. & Met. Eng.*, **37,** 160–1 (Mar., 1930).—Alcohol ranks first in quantity and value of all organic chemicals. It is used in anti-freeze mixtures, cellulose industries, shellac and varnish industries, toilet and perfume preparations, pharmaceuticals, etc. A discussion is given of the production of ethyl alcohol from the raw products, and of the production of synthetic alcohol. R. L. H.

The Quality of Commercial Ether. H. LEFFMAN AND C. C. PINES. *Am. J. Pharm.*, **102,** 58–62 (Feb., 1930).—Two grades of ether, the anhydrous for analytic work and that for anesthesia, need supervision. Some discussion has arisen lately concerning the possibility of anesthetic ether producing irritation and even inflammation of the respiratory tract. The article concludes that disturbance in ether anesthesia may be due to improper methods of administration or special susceptibilities, systemic or local. Nevertheless, it is necessary for manufacturers to keep their product as pure as possible. Makers of pharmacopeias should provide both comprehensive and trustworthy control tests. A study of commercial ether and of the tests for impurities was published in *Ind. Eng. Chem.*, **3,** 378 (1911). Since then, however, considerable progress has been made in the field. This article gives a summary of sample investigations. The discussion that has recently arisen relates to the presence of aldehyde, presumably acetaldehyde, and peroxide, possibly hydrogen peroxide. Aldehydes may be present even in the best grades in small amounts, but are hardly likely to produce serious results.

Peroxides seldom occur. Ordinary tin containers favor the production of aldehydes. In hospitals all packages so furnished should be transferred to amber glass bottles at once and kept in a cool dark place. Fuchsin—sulfurous acid, especially prepared according to Finck's formula [*Z. Unters. Nahr. Genuss.*, **27**, 248 (1914); also *Am. J. Pharm.*, **99**, 289 (1927)] is a delicate test for aldehydes, much more convenient than that recommended by U. S. P. X. It may be necessary to fix a toleration limit for practical control, however. The chromic acid test for peroxides is also very delicate and more convenient than that recommended by U. S. P. X. In both these tests the reagent should be poured through the sample to be tested. All packages of anesthetic ether should bear on the label in conspicuous figures the date of packing. G. O.

Preservation of Fats. G. W. FIERO. *Am. J. Pharm.*, **102**, 146–53 (Mar., 1930).—Fats and fixed oils are essential to dietitians and play a big part in many industries. Jamieson (*U. of Buffalo*) states that the life and progress of a nation depend upon the supply of fats and oils in no small measure. Most animal and vegetable fats and fatty oils, however, are susceptible to rancidity. The rancidity problem is a serious one to the soap manufacturer as many soaps become dark colored when rancid. Rancid ointments have a disagreeable odor and possess certain irritating properties which render them unfit for medical use. The exact nature of rancidity is unknown. There are certain factors, however, that are related to the problem; namely, rancid fats contain oxidation products. Rancid fats exhibit peroxide properties and contain aldehydes which respond to standard laboratory tests. Moisture is another factor. Rancid fats usually contain an abnormally high acid content due to the hydrolysis of the fatty ester by the moisture present. There are other factors which influence the rate of development of rancidity; namely, they develop but slowly in the dark; heat hastens chemical action. Metals also have an effect upon rancidity. The action of micro-organisms seems to be a question. It is usually noticed that unsaturated fats are susceptible to rancidity. There are several hypotheses explaining the action of preservatives on fats. One is that the preservative acts as a negative catalyst upon the oxidation of the fat. The most common preservative is benzoin, but even it is not perfect. Other substances reported as good preservatives for fats and oils are: sodium thiosulfate, thymol, stannous chloride, sodium silicate, salicylic acid, etc. The article concludes with the effect of preservatives upon rancidity of pure fresh leaf lard and in mixed fats. Of the large number of preservatives used, only a few were found to have preservative effects. Those which completely preserved lard were: resorcinol, 1%; oil of clove, 0.38%; guainol, 0.06%; thymol, 2.5%; creosote, 0.25%. Most mixtures of lard with other fats developed rancidity. Lard with the following did not develop rancidity: hydrogenated oil, 25%; white wax and petrolatum, 25% of each; white wax and liquid petrolatum, 25% of each; paraffin and liquid petrolatum, 25% of each. G. O.

Progress of Organic Chemistry, 1924–28. II. E. LEHMANN. *Z. angew. Chem.*, **43**, 81–90 (Jan. 25, 1930); 102–8 (Feb. 1, 1930); 130–3 (Feb. 8, 1930).—A continuation from page 66 [*cf.* THIS JOURNAL, **7**, 1192 (May, 1930)]. I. *Aliphatic Series.* 4. *Oxy-oxo-compounds* (sugar group)(cont.). *c.* Tri- and tetrasaccharides. *d.* Polysaccharides. *e.* Glycoside. 5. *Amines. a.* Characterization. *b.* Preparation. *c.* Natural amines. 6. *Carboxylic acids. a.* Monocarboxylic acids. *b.* Polycarboxylic acids. *c.* Oxy- and oxocarboxylic acids. *d.* Nitrogenous carboxylic acids. 7. *Cyan group. a.* General considerations. *b.* Cyanides and isocyanides. *c.* Cyanates and isocyanates. *d.* Thiocyanates. *e.* Complex cyanides. 8. *Carbonic acid group. a.* Derivatives of carbamic acid. *b.* Derivatives of carbon disulfide. *c.* Urea group. L. S.

The Identification of Pigments Used in Painting at Different Periods, with a Brief Account of Other Methods of Examining Pictures. A. P. LAURIE. *Analyst*, **55**, 163–79 (Mar., 1930).—Since different pigments have been used at different periods in the history of painting, the most reliable way for fixing the date or detecting forgeries and repaintings is by the identification of the pigments. The pigments are identified microscopically, chemical tests, optical examination, X-rays, and ultra-violet rays. Various pigments, with the respective tests, and some illustrations, are given. R. L. H.

Gypsum as a Construction Chemical. G. M. THOMSON. *Can. Chem. Met.*, **14**, 43–4 (Feb., 1930).—The author gives the account of the formation of building material from gypsum, in which plaster of Paris is formed. A brief history of the use of gypsum as a building material is included. A test made by the Chicago Underwriters showed that a solid gypsum tile 3 in. thick when heated to 2100°F. on one side for three hours had a temp. of less than 200°F. on the unexposed side. R. L. H.

Production and Liquefaction of Some Industrial Gases. F. A. BUREAU. *Can. Chem. Met.*, **14**, 41–2 (Feb., 1930).—A description is given of the use of liquefaction of

gases in the gas industry, which is used to separate the various gases and for the production of other gases as cyanamide and ammonia. The process of obtaining hydrogen from water gas is also described. R. L. H.

Gum, Tannin, and Resin in Relation to Specificity, Environment, and Function. J. B. MCNAIR. *Am. J. Botany*, **17**, 187–96 (Mar., 1930).—"The object of this paper is to show the taxonomic and climatic distribution of plants containing relatively large amounts of gum tannin and resin, and to determine the bearing of such facts on the functional importance of these substances." H. H. K.

Dependence of Aviation on Metallurgy. J. B. JOHNSON. *Metals & Alloys*, **1**, 450–4 (Apr., 1930).—Progress in any branch of engineering is closely related to the discovery or improvement of materials and methods of fabrication, in which aeronautics is no exception. Metals are favored on account of homogeneity, durability, permanency of volume and form under extreme atmospheric conditions, rigidity, and resiliency. Every improvement in metallurgical practice which increases the homogeneity of the metal affects aircraft performance. The composition of alloys for the various parts of the plane, and for maximum physical properties is discussed. Tables and illustrations are given. R. L. H.

Colloidal Metals as Therapeutic Agents. H. HILLE. *Clinical Med.*, **4**, 280–7 (Apr., 1930).—Unusual clinical results in the treatment of pneumonia, sepsis, rheumatism, and many other ailments by the use of Mervenol (colloidal mercury-copper sulfide), Armervenol (colloidal mercury-copper sulfarsenite), Aurol (colloidal metallic gold), and Lunosol (colloidal silver chloride) have been reported.

The heavy metal salts administered in this way are much less toxic than their crystalloidal solutions. The success so far reported demands a scientific investigation of these remedies. H. H. K.

Thyrite: A New Material for Lightning Arresters. K. B. MCEACHRON. *Gen. Elec. Rev.*, **33**, 92–9 (Feb., 1930).—Thyrite, developed by the General Electric, approaches the ideal properties desired of a lightning arrester more closely than any material yet developed. "It has the property of increasing or decreasing its resistance as the voltage is decreased or increased. The relationship does not depend on the rate of voltage application, and may be made to repeat itself indefinitely without change. Resistance and current relationships follow a definite law and can be expressed in the form of a simple hyperbolic equation." The arresters are built in 11.5 kv. sections, and their advantages lie in their permanence, small size and weight, low installation cost, and predictability of results to be expected under given conditions. Much of the data obtained from experiment is given. H. T. B.

Concerning Wire. ANON. *Chem. & Ind.*, **49**, 74–6 (Jan. 24, 1930).—An interesting description of the manufacture of wire including the preparation of alloys, heat treatment, drawing, and annealing. E. R. W.

Ferro-Alloys as Factors in Steel Production. J. T. MACBAIN. *Can. Chem. Met.*, **14**, 28–33 (Mar., 1930).—The author discusses the use of manganese, silicon, chromium, nickel, tungsten, vanadium, molybdenum, and zirconium in steels and the type of steel formed by the use of these alloying elements. R. L. H.

Protective Coating for Iron and Steel. ANON. *Chem. Age, Mo. Met. Sect.*, **22**, 8–9 (Feb. 1, 1930).—*A review of a paper by E. O. Jones.* Mechanical protection without the danger of electrochemical action is offered by paints. The choice of suitable oils, driers and pigments, and the technic of application is discussed briefly. Bituminous paints and enamels are also mentioned. E. R. W.

Recent Developments in Corrosion and Heat-Resisting Steels. R. HADFIELD, T. G. ELLIOT, AND R. J. SARGENT. *Chem. & Ind.*, **49**, 41T–51T (Jan. 24, 1930).—Faraday and Stodart prepared a rust-resisting steel by alloying iron and platinum. Faraday also experimented with chromium steel but he missed the discovery of modern "stainless steel" by not using a large enough percentage of chromium. Other interesting historical items, as well as a discussion of the physical and chemical properties of high nickel-chromium steels and the surface structure as shown by photomicrographs are included in Part 1. Part 2 deals with the industrial applications of these steels. Several illustrations are included. E. R. W.

Prevention of Corrosion of Lead in Buildings. ANON. *Chem. Age*, **22**, 97 (Feb. 1, 1930).—*Summary of a paper by F. L. Brady.* Lead has a high resistance to corrosion by concentrated inorganic acids, but it is readily attacked by dilute organic acids. Moist oxygen oxidizes lead and the product is soluble in soft water, but not in hard water. Moist oxygen in the presence of lime from cement or mortar readily corrodes lead. Organic acids from hard woods or from peaty soils frequently corrode lead. Bitumen

paint, or felt packings soaked in bitumen, offer a ready means of protection against corrosion. E. R. W.

Antimony. See abstract of **Free Radicles Two Centuries Ago** on page 1423.

Calcium. See abstract below on **Why We Need Minerals in the Diet.**

Iron. See abstract below on **Why We Need Minerals in the Diet.**

Potassium: Its Radioactivity: Its Isotopes: and Its Association with the Phenomena of Life. F. H. LORING AND J. G. F. DRUCE. *Chem. News*, **140**, 34–6 (Jan. 17, 1930).—The ash residue from a crop of potatoes fertilized with large quantities of potassium chloride yielded upon extraction potassium chloride, which upon analysis showed that 35.46 grams of chlorine were combined with 40.5 grams of potassium. This is higher than the accepted atomic weight of potassium, and would indicate a "plant fractionating process" whereby the isotopes of potassium are separated by living matters. H. H. K.

Silver. See abstract of **History of Mexico's Richest Silver Mines** on page 1423.

Occurrence of Germanium and Arsenic in Meteorites. J. PAPISH AND Z. M. HANFORD. *Science*, **71**, 269–70 (Mar. 7, 1930).—Spectroscopic evidence has been obtained of the occurrence of germanium in certain siderites, siderolites, and aerolites. Judging from the intensity and number of spectral lines the germanium in these meteorites is present in traces. Germanium and arsenic have both been extracted from Toluca and Welland siderites. G. H. W.

Earth Colors. J. J. SCOTT, JR. *Chi Beta Phi Record*, **5**, 43–7 (Feb., 1930).—A short account of three important, naturally occurring pigments; ocher, sienna, and umber. These are mainly hydrated ferric oxide, and differ only in the amounts of other metallic oxides present. H. H. K.

Ocher. See abstract above on **Earth Colors.**

Sienna. See abstract above on **Earth Colors**

Umber. See abstract above on **Earth Colors.**

Ferric Oxide. See abstract above on **Earth Colors.**

Iodine. See abstract below on **Why We Need Minerals in the Diet.**

Rubber Age Resisters. W. NORRIS. *India Rubber World*, **81**, 55–6 (Mar. 30, 1930).—Useful life of all rubber goods can be greatly extended by means of a variety of organic compounding materials classed as anti-oxidant which function to prevent deterioration by aging. N. lists the 4 anti-oxidant types, *i. e.*, (1) aldol condensation products, (2) sec.-naphthylamine derivatives, (3) ethylene diamine derivatives, and (4) aromatic diamines, which include 16 products along with their composition, physical properties, accelerating effect, their effect on plasticity, and goods in sunlight. Applications for each anti-oxidant is recommended. C. W. E.

Uses of Rubber Latex. ANON. *India Rubber World*, **81**, 65–6 (Mar. 30, 1930).—Gives list of 72 U. S. patents relating to various uses of rubber latex with a discussion of their value and import. C. W. E.

Rubber in Airplane Construction. C. SAURER. *India Rubber World*, **81**, 57–8 (Jan., 1930).—We little realize the importance of rubber in making aviation possible. Not only in tires and shock absorbers, but in rubber-lined cabins, insulators, cables, garments, etc., rubber adds materially to the effectiveness of the airplane. Most important is the new development of vulcanization of soft rubber to steel capable of a tensile strength as high as 5000 lb. per sq. in. C. W. E.

Accelerators of Vulcanization and Their Uses. See this title on page 1421.

Termite Control. ANON. *Chem. Warfare*, **16**, 699–705 (Feb. 15, 1930).—This paper is made up of circulars and memoranda of the Hawaiian Department of the Chemical Warfare Service relative to the control of termites. The use of toxic chemicals in the control of termites is outlined. Precautions to be followed in the construction of frame buildings so as to prevent the entrance of termites are given. E. R. W.

Chemical Warfare. See abstract of **Dr. Herbert Levinstein on "Chemical Disarmament"** on page 1426. See also the abstract of **Termite Control** immediately above.

Why We Need Minerals in the Diet. M. H. IRWIN. *Pract. Home Econ.*, **8**, 75 (Mar., 1930).—A discussion of iron, calcium, and iodine, as they are the ones most often lacking in the average American dietary.

Iron is the key element in the formation of the hemoglobin of the blood. The normal infant is born with a reserve store of iron in the liver, sufficient to last while the child's chief diet is milk. If the infant is not normal this supply of iron is lacking and must be made up by addition of iron-rich fruit and vegetable juices to the diet. A persistent lack of iron in the diet of a child or adult results in anemia. Small amounts of copper, if fed with iron, greatly aid in regeneration of red blood corpuscles. Liver, apricots, and peaches contain both iron and copper. Calcium, phosphorus, and vita-

min D are building materials specifically associated with calcification of bones and development of the teeth. Calcium and phosphorus are deposited in the bones and vitamin D is the regulating factor. Calcium salts also help regulate contractility of the heart and maintain stability of the nervous system. Milk is the most readily available form of calcium for the diet.

Iodine acts as the "timer" of metabolism in the form of thyroxin of the thyroid gland. If the supply is low, slow metabolism results; if high, too rapid metabolism. The thyroid gland often enlarges, causing goiter, in its attempt to take on sufficient iodine for body needs. Sea foods are all excellent iodine sources, due to the fact that iodine compounds washed out of the soil ultimately reach the sea.

Iodized table salt and the addition of sodium iodide to the drinking water are other ways of making up this deficiency. J. W. H.

Soil and Sod. A. VIEHOEVER. *Am. J. Pharm.*, **102,** 81–118 (Feb., 1930).—Though skill has grown and mother earth has disclosed her secrets, no certain mastery of soil and sod as yet has been achieved. This article is a classification of the different soils according to types and texture, and a discussion of soil population and soil fertility and the effect of adding different elements to the soil. Crop yields on various soils including drug plants, grasses, fruit, bulbs, trees, and cut flowers are given. Fair climate, fertile soil, and well-adapted crops make growing possible though parasites still prey upon root or fruit and leaf or stem. The article contains the scale perfected by Dr. Wherry of the U. S. Bureau of Chemistry and Soils showing soil reactions in hydrogen-ion concentration. The scale is based on data obtained from field tests of soil reaction preferences of plants. G. O.

The Relation of Media pH to the Bacteriostatic Action of Dyes. S. E. OWEN. *Am. J. Pharm.*, **102,** 154–8 (Mar., 1930).—Some of the present aniline dyes have been found to inhibit the growth of bacteria. The experimental work on which this report is based includes ten of the certified food dyes, gentian violet, methylene blue, and basic fuchsin. Agar with a pH range from 4.4 to 10.4 was prepared and the dye added to the media directly before pouring the plate. The pH value of media is an insignificant factor in the selective action of gentian violet, basic fuchsin, and perhaps methylene blue. Eight of the certified food tests showed no bacteriostatic action at pH ranging from 5.4 to 10.4. Guinea green inhibits the growth of *B. anthracis* in the acid range and at pH 7.4 but not in alkaline pH greater than this. Erythrosine inhibits the growth of *B. anthracis* at all values of pH studied. G. O.

The Modern Sun Cult. J. W. STURMER. *Am. J. Pharm.*, **102,** 63–80 (Feb., 1930).—An interesting lecture on sun therapy and the possibilities of the ultra-violet solar radiation being rich in this light. Wave-lengths shorter than 3600 Å. and down to 1000 A. constitute the ultra-violet radiation. We have just found out that glass does not transmit all the kinds of sun energy that man needs. Common glass transmits only the longest waves, those which are longer than 3400 Å. This explains why a sun porch transmits impoverished light. Recently special kinds of glass have been designed to transmit the solar ultra-violet light more generously. Window panes of quartz glass give the best results, but the price is still too high to be placed on an industrial basis. A cheaper substitute is cellophane, but it lacks durability and needs a special frame. If we are interested in protection rather than transmission of ultra-violet, we need but to remember the substances that allow the longer waves of the solar radiation to pass—amber, red, yellow, and orange glass. For example, cobalt glass transmits some ultra-violet while amber or red filters it out. Our present practice of keeping light-sensitive chemicals in amber glass rather than blue glass bottles is founded on sound principles and, thus, far more effective. Our clothing also intercepts the light rays and the ultra-violet radiation of sunlight. Wool is an effective filter; silk is fairly opaque; linen a trifle less so; while cotton is a bit more transparent. The most transparent textile today is rayon, an artificial silk. A paucity of solar radiation, so medical men tell us, means a slackened metabolism, an enfeebled condition, and a lower resistance to germ diseases. It is now known that when the skin is irradiated it experiences a change which forms vitamin D essential to the proper functioning of our bodies. How much sunshine we need, nobody knows.

The ultra-violet lamp offers possibilities to the chemist as a new method of identification. Since so many substances exhibit characteristic fluorescent properties, this fact may be used for the detection of adulterants in food analysis, in clinical chemistry, and in mineralogy; to detect suspected alterations of old paintings or their authenticity. In the paint industry it may be used to study the resistance of various paints and varnish mixtures to sunlight. G. O.

Ultra-Violet Light. See abstract immediately above on **The Modern Sun Cult.**

SCIENTIFIC REVIEWS AND BIBLIOGRAPHIES

Mercury. *Hormone*, **4**, 53–69 (Mar., 1930).—A series of seminar papers on the element mercury, including a discussion of the more common inorganic compounds of the element. H. H. K.

Organic Compounds of Mercury and Their Properties. *Hormone*, **4**, 96–116 (Apr., 1930).—A seminar paper. H. H. K.

Thionyl Chloride in Organic Chemistry. *Syn. Org. Chem.*, **3**, No. 4 (Apr., 1930).—Brief summary of the various uses of thionyl chloride in synthesis. H. H. K.

Valence. W. O. WALKER. *Sch. Sci. Math.*, **30**, 12–24 (Jan., 1930).—A discussion of the theories of valence, distinguishing between, and relating polar valence, non-polar valence, and electro-co-valence. Author concludes that there is great need for a theory which will explain not only mechanics of valence (why atoms are held together), but also why some atoms join and others do not. He holds that the former has met with a full explanation, but that only a little work has been done on the latter, though Rodebush has pointed out the relation of electro-affinity to ionization potential, Kharasch has explained the stability of certain molecules on the basis of the location of the valence electrons in certain energy levels, and London and Heitler have been able to predict certain relations between atoms on the basis of the new Schroedinger wave atom and Pauli's exclusion principle. B. H. B.

Accelerators of Vulcanization and Their Uses. F. EMDEN. *Rubber Age*, **26**, 599–603 (Mar. 10, 1930).—Detailed review of present state of vulcanization with accelerators is given, especially a number of accelerators with notable properties that have appeared in recent years. Nature of acceleration of vulcanization has not thus far been fully explained. Polysulfide theory of Bedford and Scott and the *o*-thiozonate theory of Feuchter are still most outstanding attempts to explain the mechanism. Both theories have too little experimental support. White [*Ind. Eng. Chem.*, **19**, 1037 (1927)] observes in certain compds. activated by powerful accelerators, the speed of vulcanization, at first very great, rapidly decreases during cure, which leads to conclusions that many accelerators are destroyed during cure. Therefore, White divides accelerators into 3 groups: (1) stable accelerators during vulcanization, *e. g.*, hexamethyltetramine and triphenylguanidine, (2) unstable accelerators at the vulcanization temperature, *e. g.*, the xanthogenates, and (3) semi-permanent accelerators. Wistinghouser (*Kautschuk*, **1929**, 75) shows that the consumption of the accelerators is dependent on nature and quantity of certain compounding ingredients. A list of 99 accelerators is given, their trade names, the manufacturers, and chemical constitution. E. divides accelerators into 4 types, ultra-, semiultra-, moderately strong, and weak accelerators. These are, respectively, derivatives of dithio acids, mercaptobenzothiazole and some aldehyde amines, disubstituted guanidines and aldehyde ammonia condensation products, and fourth, trisubstitution guanidines and formaldehyde-amines. E. gives a systematic review of the accelerators in every-day use. C. W. E.

Soil and Sod. See this title on page 1420.

HISTORICAL AND BIOGRAPHICAL

Wallach, Otto. (1) *Les Prix Nobel en* 1910. P. A. Norstedt & Soner, Stockholm, Sweden, **1910**, 50 pp. Contains a brief outline of work for which the Nobel award was made, brief biographical notes, summary of researches, and portrait. (2) *Ber.*, 70–1 (1927A). Public recognition of Wallach's 80th birthday on Mar. 27, 1927. (3) *Chem.-Ztg.*, **34**, 1305 (1910). Brief account of Nobel chemistry prize award to W. M. W. G.

Ostwald, Friedrich Wilhelm. J. H. VAN'T HOFF. *Z. physik. Chem.*, **46**, v–xvi (1903).—Biographical sketch and brief review of researches. Portrait is frontispiece to this number of the *Z. physik. Chem.* issued in honor of Ostwald. M. W. G.

Boerhaave. See abstract of **Free Radicles Two Centuries Ago** on page 1423.

Faraday. See abstract of **Recent Developments in Corrosion and Heat-Resisting Steels** on page 1418.

August Kekulé and His Importance in the Chemical Industry. A. VON WEINBERG. *Z. angew. Chem.*, **43**, 167–70 (Feb. 22, 1930).—This article contains the speech given by the author on the occasion of the centennial celebration of Kekulé's birthday in Darmstadt on November 16, 1929. The author states that the industrial chemist uses the same theories as the theoretical chemist. The theory which probably has done most for industry was the theory of the structure of benzene as had been stated in 1890 during the occasion of the 25th anniversary of the ring structure of benzene. In 1927, R. Anschütz said: Kekulé's benzene theory was the philosopher's stone of industry; it

showed industry how to make gold. Kekulé has done a great deal of work on derivatives of benzene as aromatic thioacids, resorcinol, phenyl mercaptan, diazo and azo bodies, oxyazobenzene, indigo, triphenyl methane, pyridine, camphor, and others. His famous and exceedingly well organized textbook of "Organic Chemistry" must have been a great aid to the dye plants of fifty years ago. Indirectly he also exercised great influence upon the industry through his numerous students who became executives in chemical plants.

It is a fact which is not well known that Kekulé was called upon from time to time to act as a chemical consultant and expert witness in patent law suits in which the chemical industry was greatly interested at that time. L. S.

Lavoisier, Founder of Modern Chemistry. *Laboratory*, **3**, 19–20 (1930).—Short biography. Portrait. H. H. K.

Pasteur. L. PARISOT. *Ray*, **6**, 5–17 (Nov., 1929).—A short biography and enumeration of Pasteur's discoveries. H. H. K.

My Personal Reminiscences of Pasteur. L. PARISOT. *Ray*, **6**, 18–24 (Nov., 1929).—Intimate reminiscences of a former student. H. H. K.

Paul Duden on the Occasion of His 25th Year of Service with the I. G. Farbenindustrie A.-G. E. BRYK. *Z. angew. Chem.*, **43**, 77–80 (Jan. 25, 1930).—Prof. Paul Duden was born in Soest in 1868 as the son of a famous teacher and student of the Germanic language. He studied chemistry first at Marburg, later with Karl Graebe at Geneva, then with Emil Fischer and Wilhelm Wislicenus at Würzburg, and finally with Knorr at Jena, where he was appointed professor in later years. In his doctor's thesis he had shown that the formation of pyrogallols with hydrazin was a general reaction for acids having the general formula RCH=CH—COOH and he synthesized cinnamic, crotonic, maleric, and fumaric acids by means of phenyl hydrazin instead of the acid synthesis. In 1894 he received a patent for the preparation of hydrazin by the reduction of easily obtainable nitroso derivatives of hexamethylene tetramine. By a series of ingenious experiments he later proved the structural formula of this compound. From 1894 up to 1905 he worked on dinitro methane, dinitro alcohols, dinitro paraffins, terpenes, berbeole, camphor, and many others. Together with L. Knorr he published a "Manual of Organic Chemistry." He made use of his good command of the French language by translating a French book on chemistry into German.

In 1905 he was called to the Farbwerke Höchst which later became a part of the I. G. Farbenindustrie A.-G. He soon changed from an excellent scientist to an outstanding man of chemical industry. His work now dealt with dyes, acetylene, acetaldehyde, acetic acid, acetone, methyl alcohol, esters, indigo, artificial silk, organic solvents, and others. He found a catalytic laboratory for the manufacture of acetic acid. Duden has been successful in practically all his endeavors. He is one of the most important men of the I. G. and a member of many chemical organizations.

Duden, still in the prime of life, is greatly liked and admired by his friends, coworkers, and employees because of his fine and obliging character. L. S.

Adolf Lehne. P. KRAIS. *Z. angew. Chem.*, **43**, 185 (Mar. 1, 1930).—Dr. Adolf Lehne died in Munich on February 1, 1930. He was one of the oldest and best textile chemists and colorists. Since his retirement from his teaching position at the Polytechnic Institute of Karlsruhe he devoted most of his time to the *Monatsschrift für Textilindustrie* and the *Patentberichte über Textilchemische Erfindungen*. An extensive report of his life and his work can be found in the *Z. angew. Chem.*, **39**, 568 (1926). L. S.

Dr. Theodor Plieniger. V. HEIDER. *Z. angew. Chem.*, **43**, 121 (Feb. 8, 1930).—Dr. Theodor Plieniger, who died recently, was born in Stuttgart on April 10, 1856. After graduating from high school he became an apprentice with the chemical company, Schmidt and Dillmann, Stuttgart. In 1879 he accepted a position with Enrico Mylius at Milan, Italy, and a year later with T. W. Heilgers in London. The latter company sent him to India for about ten years. In 1891 he became affiliated with the Chemische Fabrik Griesheim, A. G.; nineteen years later he was appointed president of that company. In 1916 he was given an honorary Doctor's degree by the Polytechnic Institute of Stuttgart. Later he was elected one of the administrative officers of the I. G.

During his stay in India he distinguished himself by his energy and efficiency. When he went to Griesheim he soon became one of the most outstanding men there. Together with Dr. Stroof he studied the new subject of chloralkali-electrolysis. He discovered new industrial uses for the various products manufactured by his company and founded several new plants in France, Spain, and Russia. L. S.

Dr. I. Rosenberg on the Occasion of His 70th Birthday on February 6, 1930. F. QUINCKE. *Z. angew. Chem.*, **43**, 97 (Feb. 1, 1930).—After finishing his studies in Pest,

Vienna, Zürich, and Göttingen, Rosenberg worked with Victor Meyer on thiophene and derivatives of naphthalene, with Lunge on wood tar, and with Bernthsen on methylene blue. In 1887 he was called to the "Höchster Farbwerke" where he began his work on thioacids of substituted naphthalene. In 1910 he was appointed a chemical technical consultant to the Disconto-Gesellschaft, a banking concern which is interested in chemical processes. Since then he had to deal with chemical plants of many types as, *e. g.*, production of hydrogen, mineral oils, beryllium, and others. L. S.

J. J. van Laar. E. JANECKE. *Chem.-Ztg.*, **54,** 117 (Feb. 8, 1930).—The Golden Roozeboom Medal was given recently to J. J. van Laar. This is the third time that this medal has been awarded since 1907. The other two medals had previously been given to Schreinemakers and Tammann.

Van Laar was born in Haag in 1860. He first became a naval officer. In 1881–1884 he studied at the University of Amsterdam where he was greatly attracted by the lectures of van't Hoff and van der Waals. After his graduation he taught in high schools at Middleburg and Utrecht; in 1898 he became "Privatdozent" (licensed University lecturer who receives fees but no salary) of mathematical physics and chemistry at Amsterdam; in 1907 he was appointed assistant to Roozeboom until the death of the latter. In 1907–08 he took over Roozeboom's lectures and remained a lecturer on mathematical chemistry and physics and on differential and integral calculus. On account of his health he moved to Switzerland and now he lives at Tavel sur Clarens.

His first scientific works were published in 1892. Since then he has published more than 200 articles on nearly every phase of physical chemistry. Most of these publications appeared in Dutch or German periodicals. He has also written a number of books on thermodynamics, mathematical chemistry, electrochemistry, etc. L. S.

Free Radicles Two Centuries Ago. T. L. DAVIS. *Nucleus*, **7,** 129–30 (Mar., 1930).—At present there are two kinds of radicles prevalent in organic chemistry: (1) those of the type of tri-phenyl-methyl, well authenticated by experimental evidence, and (2) those hypothetical ones so necessary to explain the mechanism of such reactions as the Wurtz. Two hundred years ago, Boerhaave, without our present knowledge of the mechanism of reactions, "prepared many compounds, speculated about the mechanism of chemical processes, and recognized that the *rationale* of metathetical reactions involves the notion that the parts of the reacting molecules exist for a time in the state of free radicles." Boerhaave's description of the preparation of "butter of antimony" is given to illustrate his process of reasoning. D. C. L.

History of Mexico's Richest Silver Mines. J. H. SKEWES. *Compressed Air Mag.*, **35,** 3015–9 (Feb., 1930); **35,** 3067–71 (Mar., 1930).—The silver mines at Pachuca, Hidalgo, Mexico, are among the oldest in this hemisphere and among the most important in the world. Silver ore was discovered there in 1534. The article deals with the discovery and the history of the development of these mines, and includes a description of the processes now in use in their operation. The article is well illustrated. E. R. W.

EDUCATIONAL MEASUREMENTS AND DATA

Objective Tests. EDIT. *Neb. Educ. Research Record*, **2,** 120–2 (Feb., 1930).—Some purposes of good examinations are: measurement of pupil ability and accomplishment, diagnosis of pupils, measurement and improvement of teaching efficiency, to provide opportunities for learning, motivation of pupil study, and pupil mental activity and determining standards or goals of attainment. Criteria of an acceptable test are listed. A review of a study of examinations given in the state of Nebraska for the year 1927–28 showed that 53% of all questions are of the objective type. This was taken as an indication that technics of preparing and administering such tests would be in order. A bibliography of ten or twelve titles seeks to meet this demand for such aid. B. C. H.

Measured Outcomes of Laboratory Instruction. R. E. HORTON. *Sci. Educ.*, **14,** 311–9 (Nov., 1929).—Written tests given to study the outcome of individual laboratory work as against the demonstration method gave the individual method preference.

Written tests perhaps do not reveal all the results obtained from laboratory work. This was proved by two tests, An Individual Performance Test and A Class Performance Test, devised by the author; the results show that individual laboratory work is superior to the demonstration method. H. H. K.

Do Students Who Study Chemistry in High School Elect That Subject in College? C. R. OTTO AND M. C. INLOW. *Sch. Sci. Math.*, **30,** 292–4 (Mar., 1930).—A study of the transcripts of 906 degree graduates of a state teachers' college, all of whom received their college degrees since 1920, and practically all of whom prepared for teaching. Following data was obtained:

Number of transcripts studied	906
Number who entered college with h.-s. chemistry	99
% of total entering with h.-s. chemistry	11
Number who entered college without h.-s. chemistry	807
% of total who entered college without h.-s. chemistry	89
Number who studied chemistry in h. s. and college	50.5
% of those who had h.-s. chemistry who elected college chemistry	50
Number who studied chemistry in college only	349
% of those who did not have h.-s. chemistry who elected college chemistry	43.2
% of those who did not have h.-s. chemistry who did not elect college chemistry	56.7
Number who did not study chemistry either in h. s. or college	458
% of total who did not study chemistry either in h. s. or college	50.5

Authors conclude that such slight difference in favor of high-school chemistry indicates failure of high-school teachers to interest students in the subject—but believe it much more important to reduce the number of teachers' college graduates who have had no chemistry at all, even though they may be going out to teach in the grade or elementary schools. B. H. B.

THE PHILOSOPHY OF EDUCATION

Education for a Better World. R. L. FINNEY. *J. Natl. Educ. Assoc.*, **19**, 91–2 (Mar., 1930).—The social institutions are the family, the local community, the state, the industries, the church, the school, the press, the standard of living, the customary recreations and the health-preserving activities. The institutions of society are the objectives of education. The intellectual resources of society consist of the means of communication, the technics of industry, the technics of amusements, the sciences, the fine arts, the creeds, the codes. In the curriculum subject matter, corresponding to the above, are language, vocational training, games and sports, the sciences, the fine arts, the new humanities. The function of the family is to give moral, cultural, and spiritual nurture. In this way the above principles are applied. Educators should improve institutions of society by preparing young people for better institutions than we have today. For this, educators should have broad scholarship, particularly in the fields of new humanities. A. E. C.

Economic Effects of Education. H. F. CLARK. *J. Higher Education*, **1**, 141–8 (Mar., 1930).—"The old economic arguments for higher education are no longer adequate; better reasons should be advanced if education is planned in terms of the economic needs of society."

Many professions are over-supplied with trained people, resulting in low remuneration for that profession; a plan should be evolved to educate the number of people required in each occupation. (See Editorial in this issue.) H. H. K.

Does High-School Chemistry Serve the Proper Purpose? *Chemist*, **7**, 3–9 (Mar., 1930).—Science in high-school courses should not be given as preparatory college courses but should be given to prepare a student for a better appreciation of life or for a place in the technical world. H. H. K.

Educating Tomorrow's Citizens. A. E. NEWMAN. *Teachers J. Abstr.*, **5**, 183–91 (Mar., 1930).—"Cages of nationalism do not exist in the world of science, art, music, and literature;" the path of world unity is through the school room. H. H. K.

Circuses or Colleges. EDIT. *Collier's* (Mar. 1, 1930).—At present we demand two things of colleges—education for young men and women and entertainment for the general public. Each is a full-time job. The spectacular sports, with the exception of football, all conduct their shows without benefit of learning.

College football is an industry comparable with professional baseball. Many intelligent young men who subsequently are successful in life are good football players; but football has little to do with their education. The interest of colleges in promoting football is chiefly financial. If colleges must have this money the game might be put on a purely professional basis and whole teams hired to represent the colleges during the season. Already the football contests are between coaches rather than colleges.

Whatever the solution, it is certain that colleges cannot be expected to serve both as circuses and as institutions of learning. J. W. H.

PROFESSIONAL

Training Secondary School Teachers in Universities. C. O. DAVIS. *High Sch. Teacher*, **6**, 109–10 (Mar., 1930).—Findings of this article are based upon a study of bulletins and printed announcements from twenty-five leading universities of the U. S. Three distinct policies for teacher training seem to be in vogue: one group stresses the

enrolment of students from the freshman year seeking to guide and direct their work throughout; another group admits students into the teacher training work only after they have had two or three years of training in a College of Arts and Sciences; the third group requires the undergraduate degree for admission and so makes the required work all upon the graduate level. Other information sought included; official name of the teacher-training unit, type of curricula required, professional subjects scheduled for prospective high-school teachers, and the kind and amount of practice teaching.

B. C. H.

The Training of Science Teachers, Here and Abroad. N. H. BLACK. *Sch. Sci. Math.*, **30,** 153–60 (Feb., 1930).—Author refers to several sets of data on formal training, professional attitude, teaching load, and training in chemistry and quotes, "Although many teachers in city high schools had but two subjects to teach, usually chemistry and physics, or chemistry and general science, their complaints of too many subjects to teach were just as numerous as those from county teachers, many of whom had five and six subjects to handle." Also, "The city high schools have, in general, teachers with a good training in chemistry and in special courses in educational methods, and with several years of experience. On the other hand the county high schools having too few students to require more than a fraction of the time of a chemistry teacher are forced to hire inexperienced teachers, many of whom have had no more than the introductory course in college chemistry." Author notes scarcity of data bearing on the subject and offers personal observations. Science teachers entering Graduate School of Education at Harvard lack training both in subject matter and methods in teaching; possibly, because of great demand for science teachers, and because of general belief that no special training is needed for science teaching, but also because higher institutions have arranged their courses for training of the specialist.

Author suggests training courses in science, and professional training including practice teaching. He notes the extensive training and practice teaching required abroad before applicant is accepted as a regular member of the staff. Also notes opportunity foreign universities offer teachers to extend their knowledge of science and improve their technic of teaching. B. H. B.

The Training of Ph.D.'s. E. DALE. *J. Higher Educ.*, **1,** 198–202 (Mar., 1930).—"A summary of the teaching experience and general training of the doctoral students at Ohio State University." H. H. K.

CONTEMPORARY NEWS AND COMMENTS IN CHEMISTRY AND EDUCATION

Preliminary Report of the Committee on Education of the American Institute of Chemists. *Chemist*, **7,** 10–2 (Mar., 1930).—Requirements for the profession of chemistry as the basis for a satisfactory plan of education are: (1) recognition of chemistry as a profession; (2) six years' minimum time for training; (3) minimum course requirements in credit hours: general chemistry, eight; analytical, eight; physical, eight; organic, eight; physics, ten; mathematics, eighteen; English, twelve; modern languages, twelve; economics, six; remaining thirty hours containing some philosophy, sociology, and social science; (4) graduate study for two years. H. H. K.

Proposed Studies in Chemical Education. EDIT. *Can. Chem. Met.*, **14,** 33 (Feb., 1930).—The Institute of Chemistry (of Canada) took what should prove to be a far-reaching and valuable step when its council proposed to establish a committee on chemical education. The subject has been treated at one chemical convention and a session will probably be arranged for at the spring Chemical Society meeting at Ottawa.

R. L. H.

The George Herbert Jones Laboratory. ANON. *Univ. Record (Univ. Chi.)*, **16,** 49–50 (Jan., 1930).—Mr. Jones, donor of the new chemical laboratory, in presenting the completed building to the University of Chicago expressed the hope that the work carried out in the new building would cement more closely the work of pure science and that of industry.

The dedication was made the occasion of the presentation of busts of Mr. Jones and the first three professors of the department; Professors J. U. Nef, Alexander Smith, and Julius Stieglitz. B. H. B.

Roozeboom Medal. See abstract of **J. J. van Laar** on page 1423.

Progressive Chemistry. EDIT. *Nature*, **125,** 333 (Mar. 1, 1930).—The following quotation will give some idea of the impression the JOURNAL OF CHEMICAL EDUCATION has made upon the editors of *Nature:*

"The JOURNAL OF CHEMICAL EDUCATION, a beautifully printed and illustrated monthly magazine of some two hundred pages, conveys a striking and even startling impression of the popularity and progress of chemical studies in the United States."

Then follows a description of the staff of the JOURNAL and the types of articles presented and ends with the following sentence:

" 'One of the hardest and most disappointing things is to endeavor to retain an active interest in chemistry after one has graduated,' is the complaint of a writer in the December *Alchemist*, the official organ of the Glasgow University Alchemists' Club. This very real difficulty would be overcome if chemists in Great Britain could develop sufficient enterprise to publish a British counterpart to the lively and stimulating American JOURNAL OF CHEMICAL EDUCATION, which is now in its seventh year." F. B. D.

The Journal of Chemical Education. See Abstract immediately above on **Progressive Education.**

FOREIGN CHEMICAL AND EDUCATIONAL CONDITIONS

The Training of Science Teachers, Here and Abroad. See this title on page 1425.

GENERAL

Dr. Herbert Levinstein on "Chemical Disarmament." ANON. *Chem. Age*, **22**, 116–7 (Feb. 8, 1930).—*A review of an address delivered by Dr. Herbert Levinstein, president of the Society of Chemical Industry, London.* Wealth is the dominant motive in both business and politics, it may be the ethical basis of our civilization. In our complex system of society international disputes are inevitable and occasionally these disputes will lead to war. The Hague convention of 1899 prohibited the ". . . . use of projectiles the sole purpose of which is the diffusion of asphyxiating or deleterious gases." At Ypres in 1915 the Germans released chlorine from cylinders containing the compressed gas. Later gas shells also contained high explosives so that their sole purpose was not the liberating of poison gas. Even ordinary high explosive shells liberate fumes which under certain conditions poison men in the neighborhood of the burst. Such shells are not prohibited by the Geneva Protocol of 1925, which does however prohibit the use of poison gas, but it does not prohibit smoke screens which in sufficient concentration are poisonous.

Gas warfare is more effective and less wasteful of human life and property than high explosives; it is less expensive in operation. Plants engaged in the peace-time manufacture of dyestuffs or pharmaceutical products may be easily altered to manufacture poison gas. It is impossible to prohibit such plants in peace time and in time of international emergency they are bound to be an important factor for both offense and defense. E. R. W.

Importance of Chemical Research. *Chem. News*, **140**, 42–3 (Jan. 17, 1930).—Concerning the past and future influence of research in developing Canadian industries. H. H. K.

Some Recent Changes in Our Attitude toward the Physical World. V. KARAPETOFF. *Sci. Mo.*, Mar., **1930**, 216–23.—Within the last thirty years a very rapid progress in the technic of measurements has extended the data of physics to extremely small quantities and the data of astronomy to enormous distances and unimaginable large intervals of time. The human mind, never satisfied with a mere accumulation of data, always wants to interpret them in terms of some general laws and relationships. The first and natural step was to extend and adopt the previously known laws of geometry, physics, and astronomy to the new data. Since these laws failed in some cases, especially in the intra-atomic world, a picture theory was evolved, patterned somewhat after the solar system. Later it became necessary to add numerous details and special laws to the picture, and even then it did not agree with many experimental data. As a reaction the picture theory of the atom has given place to a mathematical theory in which the unknown inner workings are expressed by newly devised formulas and operations for which no physical picture is offered. The proof of these formulas lies in the results obtained by applying them to measurable quantities of matter or energy. G. W. S.

Cancer as a Public Health Problem. J. C. BLOODGOOD. *Clinical Med.*, **4**, 187–91 (Mar., 1930).—The rising death rate due to cancer must be combated by an intensive campaign of public education as to its symptoms, and by devoting more money and effort to scientific research. H. H. K.

The Organic World and the Causal Principle. H. C. WARREN. *Science*, **71**, 204–8 (Feb. 21, 1930).—New and unpredictable properties come into being from time to time as new systems of material units are generated. The advent of the organism and its evolution have given rise to two new principles of activity in the universe. The various laws of cause and effect may be summed up under the general principle of the conservation of energy. The first of the principles is that of natural selection, which merely

means that the fittest organisms seem to survive. The second is that the selective principle does not compete our explanatory theory. A still higher principle becomes effective in the later stages of evolution.

The theoretical implications of the evolutionary process fully deserve that attention they have received. The theory of mutation in biology and the teleological or hormonic theory in psychology are attempts to provide a suitable explanation of the process of organic evolution. G. H. W.

Organic Evolution: Its Problems and Perplexities. A. HRDLICKA. *Science*, **71**, 230–3 (Feb. 28, 1930).—Every organic unit has and can be derived only from a closely related previous unit. Every organic unit differs congenitally more or less from every other unit and such differences tend to be transmitted to the progeny.

Problems discussed: 1. The word *evolution* means merely unraveling, unfolding. 2. Organic evolution did not necessarily begin with the cell. 3. Has origin of organic life taken place but once, or has the earth indefinite capacities in this direction? 4. Does such evolution proceed in all organisms, and with anything like a definite rate as to time? 5. Does evolution ever reverse itself? 6. What are the relative rules of mutation or sudden jumps in evolution of gradual changes? 7. Do we perceive in the species, genera, families, etc., anything like life cycles? 8. The promise is warm that man may eventually control biogeny. G. H. W.

Melioration by Matter. W. R. WHITNEY. *Gen. Elec. Rev.*, **33**, 85–8 (Feb., 1930).—There are those in each age that say that civilization has attained its zenith, but each succeeding age has been an improvement upon its predecessor. Man may be pictured as "halfway from nowhere to somewhere worthwhile." Throughout the ages forms of life have propagated their kind, but at the same time certain individuals have shown a tendency to experiment. Improvement has resulted from experimentation whether induced by curiosity or necessity. Petroff concluded from a study on dogs that "the chief condition for obtaining a goal was an obstacle." The generalization may be carried further. Man, with his powers of observation and reasoning, and knowing the value of obstacles may seek them out, and use them as stepping stones in his progress. H. T. B.

Water for Chicago's Growing Populace. J. N. THORP. *Compressed Air Mag.*, **35**, 3051–5 (Mar., 1930).—In 1840 water was sold by peddlers on the streets of Chicago at ten cents a barrel. Today the inhabitants require 923,000,000 gallons every 24 hours. This large amount of water is brought to the city from far out in Lake Michigan through eight or more large tunnels which connect cribs out in the lake with widely scattered pumping stations throughout the city. In the whole system over 100 miles of tunnels under lake and land are used. The latest tunnel is being driven through solid limestone rock at depths far below the building line in the city and from 140 to 200 feet below the water level of the lake. This tunnel, over ten and a half miles in length, is about 16 ft. in internal diameter. E. R. W.

High Schools Should Have Best Teachers. The best trained educators should be working in high schools, guiding boys and girls through the important stage of adolescence, rather than teaching college students who are not nearly so teachable, in the opinion of Dr. Daniel J. McCarthy, neurologist and professor at the University of Pennsylvania.

"The beneficial effect of education in the average student does not extend beyond the eighteenth or nineteenth year," Dr. McCarthy states, basing his conclusion on his impressions from tests made while he was quiz-master in the medical school. "In dealing with the average mind, a specialized type of education in the later years disciplines the mind and thereby increases its efficiency, but does not increase inherent brain power."

Dr. McCarthy's tests at the medical school showed that students admitted to the medical school from high schools showed as high brain efficiency as college graduates who entered the medical courses. All of these students were from twenty to twenty-four years of age, and their brains were fully formed.

In the ideal educational system, boys and girls in their teens would be taught in small classes by highly trained professors, Dr. McCarthy concludes.—*Science Service*

Local Activities

Purpose and Organization

The purpose of the Local Activities Section of the JOURNAL OF CHEMICAL EDUCATION is briefly but clearly stated in its title. Any items of local news from institutions, A. C. S. Sections, Teachers' Associations, or other organizations which are of such a nature as to make them of more than purely local interest rightfully belong to this Section.

The responsibility of reporting items for this section rests entirely with the local institutions and organizations. It is desirable to have a representative appointed to report news regularly. Suitable material sent to the editorial office before the 20th of each month will be published in the following month's journal. The Editorial Staff must necessarily reserve the right to abridge or totally reject any items submitted. If the following suggestions are followed, however, the necessity for such action will be largely obviated.

Material to Be Reported

1. Notices of local scholarships or fellowships and announcements of new or unusual courses in chemical education or special fields of chemistry.
2. Reports of dedication of new science buildings, stressing the unique features.
3. News notes concerning activities of prominent scientists and educators and of the honors and awards made to them.
4. Promotions within, or changes of, personnel of a department.
5. Notices of any special gifts to chemical organizations or departments—as fellowships, endowments, laboratory gifts, library gifts, etc.
6. Accounts of meetings, social functions, exhibitions, chemical entertainments, etc., which might be suggestive to other organizations. Where original or unusual features are included, it is desirable that they be described in some detail.

Situation Wanted: Young man 31 years old desires teaching position in some high school, private school, or small college for summer. Holds A.B. degree in chemistry and biology, A.M. degree in education. Seven years teaching experience; eighteen months experience as steel chemist. Second Lieutenant in Chemical Warfare Section of Army Reserves. Methodist. Non-user of either alcohol or tobacco. Perfect health. No preference as to location. For more information concerning qualifications, write HAROLD A. STAATS, Ripley, West Virginia.

Alabama Education Association. The Alabama Education Association held its annual meeting on April 10th, 11th and 12th, at Montgomery, Alabama. On the afternoon of April 11th, the Department of Elementary and Secondary Science, under the chairmanship of PROFESSOR C. M. PRUITT, of the University of Alabama chemistry department, enjoyed a program of interest to teachers of geography, chemistry, and general science.

"Then and Now in Laboratory Instruction" was the title of the address by PROFESSOR WILHELM SEGERBLOM, head of the department of chemistry, Phillips Exeter Academy, Exeter, N. H. He discussed changes that have taken place in the laboratory teaching of high-school chemistry during recent years and described the numerous devices and helps that teachers of the present day have at their disposal. Sample copies of THIS JOURNAL and the *Chemistry Leaflet*, which were distributed to the high-school teachers, aroused much interest. The copies were supplied through the courtesy of MR. WILLIAM W. BUFFUM, business manager of the JOURNAL.

MR. J. O. FRANK, professor of science education, Wisconsin State Teachers' College, Oshkosh, Wisconsin, spoke on "General Science and the General Science Teacher" and discussed the reasons for including this subject in the school curriculum, the general principles underlying general science instruction, and the relation of the teacher to the subject.

At the annual election of officers, PROFESSOR C. M. PRUITT was reëlected chairman of the chemistry department of the University of Alabama.

Francis Bacon Award. According to *School and Society*, BERNARD JAFFE, teacher of chemistry in the Girls Commercial High School in Brooklyn, received the Francis Bacon award, a gold medal and

prize of $7500, on April 18th, for the best manuscript submitted in a contest for the humanizing of knowledge. The presentation was made by PROFESSOR JOHN DEWEY, of Columbia University. DR. HARVEY N. DAVIS, president of Stevens Institute of Technology, also spoke. Mr. Jaffe's book, "Crucibles," for which the award was given, recounts the development of modern chemistry from the theories of the early alchemists, with special emphasis on the human factor.

The J. T. Baker Chemical Company Research Fellowship in Analytical Chemistry, Mid-Western Division. This fellowship has been awarded to MR. A. C. SHEAD, now at Oklahoma University, who will pursue his work at the University of Illinois. DR. I. M. KOLTHOFF, of the University of Minnesota, has been added to the Committee administering this Fellowship.

Battelle Memorial Institute. Battelle Memorial Institute, Columbus, Ohio, has announced the addition to its staff of RALPH A. SHERMAN to direct the program of research on combustion. For the past ten years Mr. Sherman has been Fuel Engineer with the Pittsburgh Experiment Station of the U. S. Bureau of Mines, where he conducted investigations and published numerous reports on combustion problems. For the past several years he has had charge of the field investigation of the service conditions of refractories in boiler furnaces, which the Bureau of Mines conducted in coöperation with the Special Research Committee of the American Society of Mechanical Engineers.

Mr. Sherman has published papers on combustion studies in various types of furnaces and on powdered coal, and has developed a method for determining the combustibility of coke.

Chicago World's Fair, 1933. The pure science of chemistry, and its relation to modern life and industry, will provide a theme for one of the basic exhibits at the forthcoming Chicago World's Fair which, in commemorating a hundred years of progress in the sciences, arts, and industries, will emphasize for the first time at an international exposition the debt modern civilization owes to science.

Chemistry's story will date back to the early part of the nineteenth century and will be punctuated by a series of chronological sequences illustrating fundamental discoveries of the period, 1833 to 1933, the year of the Chicago Fair. It is planned however, to carry the dramatization of chemistry in some cases back still farther in order to show the major discoveries of famous chemists.

The task of putting this fascinating story together and adapting it to a scenario is in the hands of a committee of twenty eminent scientists who, under the chairmanship of DR. ARTHUR D. LITTLE, constitute one of the thirty-four subcommittees of the National Research Council Science Advisory Committee to the Chicago Fair trustees.

It is proposed by Dr. Little's subcommittee to illustrate with illuminated models, enlarged billions of times, the various conceptions of atomic and molecular structure, beginning with the atom according to the idea of 1833, and specifically relating these concepts to the science of physics. In contrast to medieval times, when science was regarded as one of the "black arts," an alchemist's laboratory will be reproduced beside a modern laboratory equipped for research and control work. To further emphasize the progress that has been made it is proposed to reproduce the laboratory of Berzelius, or some other famous 19th century chemist.

Ten sub-divisions of the chemistry committee have been made so that this science, which deals with the whole material universe and extends into every human activity, may be adequately represented. The history of chemistry in the United States has been compiled by a group under the chairmanship of PROF. LYMAN C. NEWELL of Boston University. Dramatization of the atomic and molecu-

lar theory is in the hands of DR. SAUL DUSHMAN of the General Electric Company. Physical chemistry is under the chairmanship of PROF. FREDERICK G. KEYES of Massachusetts Institute of Technology; inorganic and industrial chemistry, DR. ALLEN ROGERS, Pratt Institute; organic chemistry, PROF. JAMES F. NORRIS, M. I. T.; agricultural chemistry, DR. A. F. WOODS, director of scientific work, U. S. Department of Agriculture; foods and nutrition, PROF. H. C. SHERMAN, Columbia University; photochemistry, PROF. W. ALBERT NOYES, JR., Brown University; photography, DR. C. E. K. MEES, director of research, Eastman Kodak Company; and chemistry of the automobile, H. C. MOUGEY, research laboratories of General Motors Corporation.

At the entrance to the chemistry exhibits it is proposed to place a monumental figure of light, color, and beauty, symbolical of chemistry. The terrestrial field of chemistry will be shown by a series of mural decorations, and stellar chemistry may be suggested by the ceiling. It is proposed to surround the exhibits with framed portraits of the men who contributed to the progress of chemistry from 1833 to 1933, relating them to exhibits of their discoveries and developments wherever possible.

Among exhibits proposed is one which will indicate the relationship of chemistry to the ordinary activities of a man from the time he wakes up in bed until he is back there again. It is also proposed to place side by side two furnished living rooms, one of the period 1833 and another of 1933, contrasting the standards of living as a result of the contributions of chemistry and allied sciences. The relations of chemistry to the various industries will be similarly shown, especially in the fields of agriculture at harvest time, photography, and automotive production, a field in which it is not generally known.

A definite scheme of integrating these exhibits into the chemistry scenario, and of correlating the story of chemistry with the whole dynamic drama of the sciences, is now being worked out by the executive committee of the Science Advisory Committee, under the direction of DR. FRANK B. JEWETT, as the basic pattern for the Chicago Fair. The preliminary plan drawn by the science committee provides for the housing of the pure sciences in a central Temple of Science, the applied physical and biological sciences to be grouped in proximity to the Temple, and the applied earth sciences in a man-made mountain range.

Eighth Colloid Symposium. The following papers will be presented at the Eighth Colloid Symposium which will be held at Cornell University, June 19, 20, and 21, 1930.

WEISER, HARRY B. The Rice Institute. "The Mechanism of the Coagulation of Sols by Electrolytes. I. Ferric Oxide Sol."

THOMAS, ARTHUR W., and THOMAS H. WHITEHEAD. Columbia University. "Ionic Interchanges in Aluminum Oxychloride Hydrosols."

BURTON, E. F., and M. ANNETTS. University of Toronto. "Equilibrium Phenomena in Coagulation of Colloids."

NEVILLE, HARVEY A., and CHARLES T. OSTWALD. Lehigh University. "The Stabilization of Blue Hydrous Cupric Oxide."

MASON, C. W. Cornell University. "Transmitted Structural Blue in Microscopic Objects."

HOLMES, HARRY N., and A. L. ELDER. Oberlin College. "The Vapor-Adsorption Capacity of Silica Gels as Affected by Extent of Drying before Wet-Heat Treatment and by Temperature of Acid Treatment and of Activation."

GERMANN, F. E. E. University of Colorado. "The Relation between Photographic Reversal and the Sensitivity of the Silver Halide Grain."

MCNALLY, J. G., and S. E. SHEPPARD. Eastman Kodak Company. "The Thermoelastic Effect in Cellulose Ester Films."

DAVEY, WHEELER P. Pennsylvania

State College. "A Method for Measuring Average Particle Size of Emulsions."

SEIFRIZ, WILLIAM. University of Pennsylvania. "The Ultra-Microscopic Structure of Living Plants."

MCBAIN, J. W., and S. S. KISTLER. Stanford University. "Ultrafiltration as a Test for Colloidal Constituents in Aqueous and Non-Aqueous Systems."

BISHOP, G. H., FRANK URBAN, and H. L. WHITE. Washington University Medical School. "Study of the Blocking Effect of Cellophane Membranes."

RUTZLER, J. E., JR. Cornell University. "The Denaturation of Albumin."

NORTHRUP, JOHN H., and MOSES KUNITZ. Rockefeller Institute of Medical Research. "The Swelling and Hydration of Gelatin."

ANSON, MORTIMER L., and ALFRED E. MIRSKY. Rockefeller Institute of Medical Research. "The Reversibility of Coagulation of Proteins."

BANCROFT, GEORGE. Cornell University. "The Equilibrium between Glycogen and Lactic Acid."

RICHTER, G. H. National Research Council Fellow at Cornell. "The Chemistry of Anaesthesia."

NUGENT, R. L. Gladwyne Research Laboratory. "The Chylomicron Emulsion."

ABRAMSON, HAROLD A. Harvard Medical School. "The Factor of Proportionality for Cataphoretic and Electroendosmotic Mobility and Its Biological Significance."

BULL, HENRY B., and ROSS AIKEN GORTNER. University of Minnesota. "Studies on Electro-Kinetic Potentials. VI. Electrical Phenomena at Interfaces."

MOONEY, M. U. S. Rubber Company. "Cataphoresis and the Diffuse Ionic Layer."

WILLIAMS, J. W., and V. A. VIGFUSSON. University of Wisconsin. "Potential Differences at Air-Liquid Interfaces."

WILLIAMSON, R. V. E. I. du Pont de Nemours and Company. "Some Unusual Properties of Colloidal Dispersions."

BRADFIELD, RICHARD. Ohio State University. "Some of the Chemical Reactions of Colloidal Clays and Their Physical Effects."

SCOTT BLAIR, GEORGE W. Cornell University. "Measurements of the Plasticity of Clays."

JEBENS, WALTER. Cornell University. "Studies in the Plasticity of Paint."

FRAZER, J. C. W. The Johns Hopkins University. "The Catalytic Oxidation of Carbon Monoxide."

German Chemical Apparatus Exposition. According to *Industrial & Engineering Chemistry, News Edition*, progress has been made toward the German Chemical Apparatus Exposition, which will be held at Frankfort a/M, June 10th to 22nd. There are now about 220 exhibitors.

The Deutsche Gesellschaft für chemisches Apparatewesen E. V., located at Seelze bei Hannover, Germany, which is the directing organization, has issued the Achema Year book, which is a volume of information regarding the forthcoming Sixth Exposition. This book contains descriptive matter regarding the exhibits and the exposition and will be sent upon request to those interested, the German organization requesting only that the postage be sent in the form of Two International Reply Slips, which may be secured at the United States Post Office.

American representatives are the International Exposition Company, Grand Central Palace, New York, N. Y.

Lectures will be given during the exposition, including a series of student course lectures such as have been given for many years at the Exposition of Chemical Industries in the United States. Motion pictures will also be shown; exhibitors will be able to show their films.

The last exposition drew together 266 exhibitors and 24,975 visitors. About 10,000 were chemical engineers and those associated with the chemical industry.

John Simon Guggenheim Memorial Fellowship. According to *The Nucleus*, DR. EVALD LAURIDS SKAU, assistant pro-

fessor of physical chemistry at Trinity College, Hartford, Connecticut, has been awarded one of the Guggenheim Fellowships for study abroad.

Professor Skau has developed a special technic for determining the purity of low-melting organic compounds by measuring their cooling and melting curves in apparatus of his own design. The cooling medium used in liquid air and the freezing points are determined by using thermocouples. Since 1928 Dr. Skau has been associated with the Rockefeller Institute for Medical Research in the work on the purity of organic compounds.

Professor Skau plans to sail for Europe in August. He will spend a year studying in Brussels, Munich, Frankfort-am-Main, Zurich, and other cities. He expects to collect many samples of organic compounds for further study. Continuation of the writing of a book on the purification of organic compounds and methods for determining their purity will occupy a large share of his attention.

Mellon Institute of Industrial Research. In his seventeenth annual report to the board of trustees of Mellon Institute, DIRECTOR E. R. WEIDLEIN has summarized the activities of the institution during the fiscal year ended February 28, 1930. The sum of $929,109.02 was contributed by Industrial Fellowship donors in support of research—an increase of $129,025 over the preceding year. The total amount of money appropriated to the Institute by companies and associations, for the nineteen years ended February 28, 1930, was $6,749,273.

Throughout the entire fiscal year 71 Industrial Fellowships, requiring the services of 209 full-time research men, were in operation. Sixty-one Industrial Fellowships—21 Multiple Fellowships and 40 Individual Fellowships—were active at the beginning of the new fiscal year. Eight are being sustained by industrial associations. The industrial research personnel consists of 21 Senior Industrial Fellows, 88 Industrial Fellows, 34 full-time Fellowship assistants, and a number of part-time assistants.

Especially notable results have been forthcoming from the following investigations: air pollution, bricklaying, carbonated beverages, cooking utensils, food varieties, heat insulation, iodine, laundering, organic synthesis, petroleum production, sleep, and vitrified sewer pipe. Ten fellowships completed their research programs: beds, cast iron (2 fellowships), chrome plating of aluminum, gum, hats, industrial alcohol, licorice, stearic acid, and surgical supplies. Nine fellowships became active during the fiscal year: can, fatty acid uses, garment, hemp paper, nicotine, oxygen, rosin oil, steel treatment, and wood by-products. Five new fellowships have been accepted and their operation will be begun during the early part of the new fiscal year.

The Institute's department of research in pure chemistry has continued its work on acidic carbohydrates occurring in plants and on other problems in the province of sugar chemistry.

Of the 61 fellowships now active, 29 have been in operation for 5 years or more. Of this number 15 have completed more than 10 years of work.

The publications by members of the Institute during the calendar year 1929 included 7 bulletins, 50 research reports, and 59 other papers. Sixteen U. S. patents were issued to Fellows of the Institute. The total contributions to the literature for the 18 years ended January 1, 1930, have been as follows: 15 books, 96 bulletins; 528 research reports; 849 other articles; and 407 U. S. patents. These publications are listed in the Institute's Bibliographic Bulletin No. 2 and its three annual supplements, copies of which will be sent to research directors, science teachers, and librarians upon request.

Copies of the full report are available to all interested persons.

Museum of Science and Industry. The appointment of DR. LOUIS EHRENFELD, of

Northwestern University, to the position of Curator of Organic and Industrial Chemistry for the Museum of Science and Industry, Chicago, was recently announced.

The North Louisiana Chemical Society. This association is an organization of commercial chemists which has recently been organized at Shreveport, Louisiana. The average attendance at the monthly meetings has been about thirty-five. MR. W. F. FULTON is president, and MR. A. W. TRUSTY, of the Louisiana Oil Company, is secretary.

The Ohio State Chemistry Teachers' Association. The Association met at Columbus, Ohio, April 5th, in conjunction with the Non-Biological Section of the Ohio State Educational Conference. The following officers were elected: ERWIN H. SHADE, Harding High School, Marion, *chairman;* DR. ROY I. GRADY, Department of Chemistry, Wooster College, Wooster, *secretary-treasurer;* VERNON S. CULP, West High School, Akron, member of Senate of Chemical Education, representing high schools for the next three years.

It was decided that again this year certificates of effort would be given the 250 contestants in Ohio in the Seventh Annual Prize Essay Contest. Last year 162 of these certificates were mailed to contestants. The work of the organization for the coming year will be acquainting teachers with the *Chemistry Leaflet* and urging its adoption as a supplement to the chemistry text.

Boston College. A number of courses in undergraduate chemistry will be offered in the extension school from June 30th to August 4th, this year. These include courses in general, analytical, organic and physical chemistry, chemical bibliography, and chemical biography.

Boston University. MISS VERA L. WRIGHT and MR. ALBERT J. PLUMMER, who graduated with distinction in chemistry last year, have been retained as assistants, the former in general chemistry and the latter in physical chemistry.

A new course in chemistry has been added to the curriculum of the Sargent School of Gymnastics which was recently acquired by the department of education. DR. J. PHILIP MASON is conducting this course. He is also supervising the installation and equipment of a new chemical laboratory at the school.

DR. LYMAN C. NEWELL gave the chemistry lectures in a new course called "College Science" which is being tried out this year in the department of education. Three other instructors are coöperating with Dr. Newell, who organized the course.

The Northeastern Section of the A. C. S. has appointed Dr. Newell historian of the Section. He has been requested to go over the records from 1898, when the section was organized, and select data which can be used for various historical purposes.

Dr. Newell is a member of the committee which prepared the report on a chemistry exhibit in connection with the Centenary of Progress to be held in Chicago in 1933. His special contribution is a plan to illustrate discoveries and inventions from 1833 to 1933 by a series of framed portraits to be hung near the exhibits.

Brown University. DR. C. J. WERNLUND of the Roessler and Hasslacher Co., New Jersey, addressed a joint meeting of the Rhode Island Section of the A. C. S. and the Rhode Island Branch of the American Electroplaters' Society in the auditorium of the Jesse Metcalf Laboratory on April 18th. His topic was "Cadmium and Zinc Alloy Plating."

On May 9th, DR. A. D. HIRSCHFELDER, of the University of Minnesota, addressed the section on the topic "The Physical Chemistry of Antiseptics."

The second John Howard Appleton Lecture of the year was held on April 21st. DR. W. A. NOYES, Professor Emeritus of the University of Illinois, spoke on the subject "Valence."

The students' Chemistry Club met on April 11th. PROFESSOR CHARLES W. BROWN, of the Geology Department, talked to the group about his recent trip to China. The annual spring outing of the Club was held in Lincoln Woods on Saturday afternoon, April 26th.

DR. CHARLES A. KRAUS has returned to Providence after an extended trip to the Pacific Coast and parts of the Middle West.

College of William and Mary. The College of William and Mary and the department of chemistry were hosts on Saturday, March 15th, to the Virginia Section of the A. C. S. and the Hampton Roads Chemists' Club. It has been the custom for the last several years for these two organizations to hold a joint meeting each spring in the vicinity of Hampton Roads. This year the meeting was concerned primarily with sea-food products and their possible development in Virginia. This subject is of so much interest in this state at this particular time that GOVERNOR JOHN GARLAND POLLARD and other state officials attended. DR. D. K. TRESSLER, of the Frosted Foods Company, was the principal speaker. He dealt especially with the problem of preserving sea foods so as to market them in a wholesome and attractive condition and thereby increase the trade. Following the address, which was at 5.30 P.M., dinner was served at the College Refectory.

March 15th will be remembered at the College of William and Mary, not only because of the chemical meeting just mentioned, but because of a fire in the chemistry laboratory which destroyed the attic and practically wrecked the third floor. The fire started from trash which was being carried down on the elevator. The draft carried the fire right to the roof and it soon spread through the attic. (*This may be taken as a warning to extend all elevator shafts through the roof in a chimney-like fashion instead of having them terminate in the attic.*) The walls of the third story were badly cracked by heat, making it necessary to rebuild that story. However, the loss of apparatus was relatively small and the first two lower stories were not greatly damaged. Work has been carried on on those two floors, not a single lecture having been omitted.

Cornell College. On April 23rd, the Iowa Section of the A. C. S. held two sessions with the State University of Iowa. In the afternoon the teaching of high-school chemistry was discussed. The following participated in the discussion: CHARLES B. YAGER of Iowa City; BEN H. PETERSON of Coe College; L. P. SHERMAN of Grinnell College; T. H. LIGGITT of Central College; and J. B. CULBERTSON and N. KNIGHT of Cornell College. In the evening, PRESIDENT WILLIAM MCPHERSON gave a lecture on "Some Reminiscences of Great Teachers of Chemistry." Both sessions were largely attended.

Organic research at Cornell College, Mt. Vernon, Iowa, is in progress under J. B. CULBERTSON and chemistry major students. The subjects under investigation are the preparation of monohydroxy diphenyl ketimines and also a study of the Haesch-Houber synthesis of aromatic ketimines and imino-esters.

DR. N. KNIGHT and WILLARD C. STEWART are continuing the study of substances dissolved in rains and snow. They determine in each sample chlorine, nitrates, nitrites, free and albuminoid ammonia and sulfates. Most of the precipitations contain chlorides which must be carried from the Atlantic or Gulf of Mexico. The precipitations usually occur when the wind is in the east or south.

Franklin College. The chemistry club of Franklin College, Franklin, Indiana, has sponsored a series of talks by prominent chemists in various fields during the past semester. These talks have been of a non-technical nature and open to the student body and public.

The first talk of the series was given just before Christmas by PROFESSOR RANDOLPH, of the Indianapolis College of Pharmacy, on "Hormones."

DR. R. N. HARGER, professor of biochemistry and toxicology at the Indiana Medical School, was the speaker at the March meeting. He spoke on "Chemical Methods of Analyzing Ailments."

The April meeting of the club was a dinner meeting, with MR. and MRS. SHONLE as guests. Mr. Shonle, who is director of organic research for the Eli Lilly pharmaceutical corporation of Indianapolis, later spoke to the open meeting on "The Synthesis of Drugs."

DR. R. B. MOORE, dean of the school of science of Purdue University, will address the May meeting on some phase of the rare gases.

All juniors and seniors majoring in chemistry attended the student meeting of the Indiana section of the A. C. S., April 4th and 5th.

Galloway College. MISS GLADYS MURPHY, a senior at Galloway College, Searcy, Arkansas, has been appointed as lecture assistant for the coming year to DR. HARRISON HALE, head of the chemistry department of the University of Arkansas. Miss Murphy will pursue work toward the M.A. degree.

MISS GERTRUDE WESTMORELAND, a student of freshman chemistry at Galloway, has received $200 as third prize in the national chemistry essay contest. Miss Westmoreland's subject was "Chemistry and Public Health."

Honor students in first-year chemistry are WILLINE FORREST, GERTRUDE WESTMORELAND, BERNICE MEDLEN, and PAULINE WALKER. In second-year chemistry GLADYS MURPHY and MARGARET ANN LAKE rank first and second, respectively.

Georgetown University. At the last meeting of the Chemistry Teachers' Association of the District of Columbia, the following officers were elected for the ensuing year: DR. JOSEPH A. MULDOON, Georgetown University, *chairman;* MR. ELMER KREHBIEL, McKinley High School, *secretary;* DR. HENRY P. WARD, Catholic University, MR. ALLEN J. MARSH, McKinley High School, and REV. GEORGE L. COYLE, S. J., Georgetown University, *senators.*

In February, The Chemical Foundation, Incorporated, announced the publication of the report of the committee which was appointed by the National Research Council to study the construction and equipment of chemical laboratories. The committee consists of S. M. DENNIS, Cornell University; C. R. HOOVER, Wesleyan University; L. W. MATTERN, McKinley High School, Washington, D. C.; J. N. SWAN, University of Mississippi; and REV. GEORGE L. COYLE, S. J., *chairman,* Georgetown University.

The Chemistry Academy of Georgetown University at its second public meeting of the scholastic year had as its guest speaker MR. W. F. COLLINS, who is in charge of the Analysis of Water Department of the U. S. Geological Survey. Mr. Collins is an authority on the analysis of drinking water and gave an interesting discussion of "The Preparation of Potable Water."

Geneva College. The John Wiley and Sons, Inc., Fellowship for Pennsylvania to The Johns Hopkins University was recently awarded to DONALD A. WILSON of Geneva College. JOHN C. HECKER has received an appointment to Yale University for next year as an assistant in chemistry. FLORENCE JENNEY has been awarded, by the Congress of Women's Clubs of Pittsburgh, a four-year fellowship to the University of Pittsburgh School of Medicine.

Harvard University. GEORGE BOGDAN KISTIAKOWSKY has been appointed assistant professor of chemistry at Harvard University. Prof. Kistiakowsky, who is a native of Russia, received the degree of Doctor of Philosophy at the University of Berlin in 1925. While there he worked in Prof. Bodenstein's laboratory. Since then he has been a member of the department of chemistry at Princeton University.

Prof. Kistiakowsky's chief line of research has dealt with the photochemistry and mechanism of gaseous reactions. He has also published a number of papers on contact catalysis and allied subjects. Perhaps his name is most familiar to chemists of this country as a result of his book "Photochemical Processes," which appeared in 1928 as an A. C. S. Monograph.

While at Harvard, Prof. Kistiakowsky plans to give lectures in advanced physical chemistry, to conduct a seminar in recent developments in physical chemistry, and to direct research along these lines.

According to *Science*, DR. JAMES BRYANT CONANT, professor of organic chemistry of Harvard University, has been elected a member of the board of scientific directors of the Rockefeller Institute for Medical Research.

Howard College. MR. JAMES WATTERS has been appointed an instructor in the department of chemistry for the session 1930–31. Mr. Watters is graduating in three years with an entire record of A grades.

Three members of the staff attended the Seventh Annual Meeting of the Alabama Academy of Science held in the new Ross Chemical Laboratory of the Alabama Polytechnic Institute, April 18th and 19th. PROFESSOR JOHN R. SAMPEY presented a paper on "Halogen Naphthylamines and New Evidence for Intermediate Compound Formation in Hydrogen Ion Catalysis."

James Millikin University. A course in physical chemistry will be offered, beginning next fall, by the chemistry department of The James Millikin University. It will be under the direction of ASSOCIATE PROFESSOR F. H. RATHMANN.

DR. J. H. RANSOM, head of the chemistry department of The James Millikin University, has been appointed a member of the committee to represent the faculty in the selection of a president for the college to succeed MARK E. PENNEY, who recently resigned.

Kansas State Agricultural College. DR. HARRISON E. HOWE, editor of *Industrial and Engineering Chemistry*, was the speaker at the March meeting of the local section of the A. C. S. held in Denison Hall, Monday evening, March 17th. His subject was "Discoveries of the Future."

Loyola College. DR. WM. M. THORNTON, JR., associate professor, The Johns Hopkins University, recently gave a lecture to the Loyola Chemists' Club. His topic was "General and Industrial Chemistry of Titanium."

DR. LOUIS C. ROCHE conducted the members of the Loyola Chemist's Club on a tour of inspection at the Maryland Glass Corporation. After inspecting the plant, DR. ROCHE and W. LESSNER, chief chemist, gave lectures on the methods of glass manufacture.

MR. P. A. KLEFF, '29, was awarded a fellowship in chemistry at Holy Cross College, Worcester, Mass.

Middlebury College. Summer courses in chemistry at Middlebury College, Middlebury, Vermont, will include general chemistry, qualitative and quantitative analysis, organic, physical, and industrial chemistry. The instructors will be: P. CONANT VOTER, *chairman*, department of chemistry, Middlebury College; J. FESSLER HALLER, Middlebury College; DAVID E. WORRALL, Tufts College; JOSEPH S. THOMAS, Harvard University; WALLACE M. KELLEY, University of Georgia.

Further information regarding these summer courses may be obtained from DEAN P. CONANT VOTER, Middlebury College, Middlebury, Vermont.

Missouri School of Mines and Metallurgy. DANIEL C. JACKLING, of San Francisco, Calif., president of the Utah Copper Company, has made provision for the establishment at the Missouri School

of Mines and Metallurgy at Rolla, of which he is a graduate of the class of 1892, of the Jackling Foundation for education in the sciences and arts pertaining to the mineral industry, the purpose of the Foundation being to aid worthy students through school by means of generous loan funds and to provide scholarships and special educational features not ordinarily provided for at state schools.

The Foundation, through contributions already made and to be made by Mr. Jackling, may eventually total $600,000. Of this amount one hundred thousand dollars are to be used as loan funds and the income from five hundred thousand dollars will be used for scholarships and special educational purposes. About twenty years ago Jackling established the Jackling Loan Fund at the School of Mines, which fund has already helped over three hundred students through the school.

In establishing the foundation, Mr. Jackling specifically requests that the income from it be used in no way that will lessen the support the school is to receive from the State, expressing it as his conviction that a state is indebted to a state school for sufficient funds for operation. He stated it as his aim to further the prosperity of the mining and metallurgical industry by means of education in the arts and sciences pertaining to this industry, and expressed a desire to create a situation centering around the Missouri School of Mines that would go far to make it one of the leading factors for engineering education in this country at least, and possibly abroad.

Under the provisions of the Foundation, no loans, except in unusual cases, are to be made during the freshman year. During the second year not more than one-half of the average normal cost of one year's work is to be loaned. During the third year not more than three-fourths of such cost, and during the fourth year the student may borrow sufficient to meet all reasonable expenses. Not all of these provisions will be met at the present time, but the amounts will be increased as the fund grows until the full amounts listed above will be available.

One of the special features of the second branch of the Foundation, known as the Educational Fund, is the arrangement for the granting of scholarships for advanced study, either in American schools or abroad, and the granting of such scholarships to foreign students for study in America. This feature is along the lines of development the present administration of the school has long had in mind, as DIRECTOR CHARLES H. FULTON has felt that American mining and metallurgy owes much to the schools of the old world for the aid their graduates gave to our country during the early development period before our mining schools were established.

The income from the Educational Fund is also to be used for the temporary or permanent appointment in any department of the school of faculty members in special fields of the mineral industry not provided for by the legislature, or for special research by the staff of the school on some definite problem of research. The income may also be expended for the payment of expenses and fees of distinguished lecturers in the sciences and arts pertaining to the mineral industry, or for other legitimate needs of the school, its student body, or its alumni.

The Ohio State University. The first term of the summer quarter of the Ohio State University will extend from June 16th to July 23rd, and the second term from July 24th to August 29th. A student may register for either term or for the entire quarter. Practically all courses required of undergraduate students majoring in chemistry, as well as the ones which are prerequisite for advanced degrees will be offered. Research work leading to advanced degrees will be offered in the fields of analytical, inorganic, organic, and physical chemistry.

The following members of the faculty will be in residence. PROFESSORS C. E. BOORD (organic), W. E. HENDERSON

(inorganic), H. L. JOHNSTON (general and physical), EDWARD MACK (physical), and H. V. MOYER (analytical). In addition to these members of the regular staff, PROFESSOR THOMAS MARTIN LOWRY, C.B.E., F.R.S., professor of physical chemistry, Cambridge University, England, and PROFESSOR RICHARD ALLEN MORTON, D.Sc., Ph.D., F.I.C., University of Liverpool, England, will be visiting professors in the department during the summer quarter.

Dr. Lowry's work in the fields of dynamic isomerism, valence, and optical rotation is well known. He will offer a course on Optical Rotatory Power (July 1st to July 23rd), and one on The Physical Basis (mainly spectroscopic) of Chemical Theory (Second Term). During the second term, Dr. Morton will present a course on Photo-Chemistry, in which he will outline some of the newer advances in this field and at the same time he will discuss the recent work of E. C. C. BALY (University of Liverpool), which has resulted in the fabrication of certain sugars photosynthetically. In addition, Dr. Morton will present (the quarter) a series of lectures in certain advanced fields of organic chemistry.

Of added interest to all graduate chemistry students will be PROFESSOR H. A. WILSON'S (Rice Institute) courses on the Conduction of Electricity through Gases and The Application of Thermodynamics to Chemical Phenomena; and also PROFESSOR W. W. WATSON'S (Yale) course on Molecular Spectra. PROFESSOR R. E. LANGER (Wisconsin) will offer a course in mathematics which will appeal to those studying the Schroedinger atom and related topics.

PROFESSOR EDWARD MACK, JR. is a member of the Executive Committee of the Sub-Committee on Chemistry and Chemical Technology of the National Research Council.

Papers by DR. A. H. COMPTON (University of Chicago), DR. SAUL DUSHMAN (Research Laboratory, General Electric Company), PROFESSOR H. T. STETSON (Ohio Wesleyan University), PROFESSOR ALPHEUS W. SMITH (Ohio State), and PROFESSOR H. L. JOHNSTON (Ohio State) were presented before the Physical Science section of the 10th Annual Educational Conference on April 4th. PROFESSOR W. L. EVANS (Ohio State) was the presiding officer.

The Executive Committee of the Ohio Chemistry Teachers' Association had a dinner meeting on April 3rd. On April 4th the Association had a group luncheon and business session with MR. MARTIN V. MCGILL, of Lakewood High School, presiding.

PROFESSOR CHARLES KRAUS of Brown University was the guest of the Ohio State Chapter of the Phi Lambda Upsilon Society and the Columbus Section of the A. C. S. on April 7th. Columbus was the last stop on the nation-wide tour of Dr. Kraus while studying graduate curricula, graduate student problems, and the graduate student needs of the industries. The evening address for the Columbus section was on "The Boundary between Organic and Inorganic Chemistry."

PROFESSORS WILLIAM MCPHERSON, W. E. HENDERSON, J. R. WITHROW, and C. E. BOORD and DOCTORS W. C. FERNELIUS and M. L. WOLFROM attended the Atlanta Meeting of the A. C. S. PROFESSOR D. J. DEMOREST was on the program but at the last minute found it impossible to leave Columbus because of a court case in which he is one of the expert technical witnesses.

The following programs are the plans of the Columbus Section, A. C. S., for the remainder of the year:

April 23rd, afternoon and evening. DR. LINUS PAULING, of the California Institute of Technology, discussed "The Rotational Motion of Molecules in Crystals with Special Reference to the Entropy of Hydrogen" and "Inorganic Crystals Including the Silicates."

May 14th and 15th, K. FAJANS, of the University of Munich, spoke on his work in physical chemistry.

May 23rd, H. E. OTTING, of Moores

and Ross Milk Company, will speak on "Problems in the Manufacture of Milk." This meeting will be held in the auditorium of the Ohio Wesleyan University.

The department of chemistry has just acquired an interesting apparatus, a Hilger Quartz Spectrograph, for investigational work in the ultra-violet region.

The Pennsylvania State College. A local chapter of Sigma Xi honorary scientific fraternity was installed on Friday, April 4th. DEAN EDWARD ELLERY, of Union College, national secretary of the society, presided. A public address on "Radioactivity and the New Chemistry" was given by Dean Ellery on the same day. There was an unusually large attendance.

DEAN WHITMORE and PROFESSORS CHANDLEE, GEIST, and MACK of the chemistry department attended the meeting of the A. C. S. at Atlanta, Georgia.

MR. W. E. COUGHLIN has completed his requirements for the doctorate in chemistry and is now engaged in special investigation work here.

DR. F. K. RICHTMEYER, of the physics department, Cornell University, addressed the Sigma Pi Sigma honorary physics fraternity at State College, Tuesday and Wednesday evenings, May 6th and 7th. He also addressed the Physics Seminar group. The physics teachers in the nearby high schools were invited to the lecture on May 6th.

DR. E. D. RIES, head of the department of chemical engineering, has resigned his position to accept an appointment with the Ammonia Division of the du Pont Company. He will be engaged in large scale plant design and development work.

Princeton University. Present graduate students have received the following appointments to fellowships and assistantships for the next academic year: A. T. WILLIAMSON, Charlotte Elizabeth Proctor Fellow; W. F. JACKSON, Charlotte Elizabeth Proctor Fellow; D. V. SICKMAN, Albert Plaut Fellow; R. W. DORNTE, du Pont Fellow. *Part-Time Assistants:* P. D. HAMMOND, C. S. HITCHCOCK, W. B. KEIGHTON, C. C. LYNCH, D. J. SALLEY, W. H. TAYLOR, W. S. WALLS. *Research Assistants:* D. A. LACOSS, K. B. MCALPINE. *American Petroleum Institute Fellows:* J. M. MORTON, G. F. WALZ, G. N. WILDER.

Incoming graduate students have received the following appointments: *Fellows:* C. H. LINDSLEY, Sayre Fellow, Princeton University; E. B. WILSON, JR., Harvard Fellow, Princeton University. *Part-Time Assistants:* A. CONLIN, University of Vermont; W. P. MUNRO, University of Iowa; E. D. REEVES, Williams College; J. A. REID, University of Wisconsin; T. V. RICH, University of Vermont; A. SHERMAN, University of California. *Research Assistants:* R. P. METCALF, Oberlin College; O. B. HAGER, University of North Carolina; G. J. DERGE, Amherst College.

Shurtleff College. On June 1st, PROFESSOR R. K. CARLETON will leave Shurtleff College, Alton, Illinois, to take charge of the chemistry department of the State Teachers' College at Cape Girardeau, Missouri, during the summer session which ends August 1st. On October 1st, Professor Carleton will join the faculty of the George Peabody College for Teachers, where he will complete the requirements for the Ph.D. degree. During Professor Carleton's absence MR. HOMER R. DUFFEY, M.S., University of Illinois, 1928, will take his place.

The Sigma Zeta Society, which was founded at Shurtleff College in 1925, has grown until there are seven active chapters, and each year holds a conference or conclave which delegates of the various chapters attend. This year the conclave was held on April 11th–12th at Otterbein College, Westerville, Ohio.

Sigma Zeta was founded with the purpose of giving recognition to undergraduate work of high scholarship in science (mathematics, chemistry, physics, and biology), and the conclave is to be made a time when any undergraduates of the

schools where the various chapters are located may present papers on any original or semi-original work they do. This year the following papers were presented: DR. R. K. CARLETON, "Celanese." DR. L. A. WEINLAND, "Crystals." JOHN LOGAN, "An Outline of the Physical Chemistry Course as Taught at Shurtleff College." MR. BUNDY, "A Demonstration of Conduction through Gases at Low Pressures." L. POUNDS, "A Brief Outline of the Einstein Theory of Relativity."

Smith College. DR. MARY LOUISE FOSTER, professor of biochemistry at Smith College, has received a grant from the American Council of Learned Societies for the study of "Alchemy in Spain." Dr. Foster will sail for Spain in June and expects to work in the libraries at Salamanca, Madrid, El Escorial, and Barcelona.

MISS DOROTHEA BARNÉS, a graduate of University of Madrid, and a graduate student in biochemistry at Smith College this year, has received a scholarship award from Yale University and will continue graduate study there next year.

Stanford University. The promotion of DR. GEORGE S. PARKS to the rank of associate professor was recently announced.

PROFESSOR LINUS PAULING, of the California Institute of Technology, spoke on April 7th on "The Rotational Motion of Molecules in Crystals with Particular Reference to the Entropy of Hydrogen."

PROFESSOR E. C. FRANKLIN has recently taken and exhibited a motion picture of close-ups of members of the department.

Trinity College. PROFESSOR VERNON K. KRIEBLE, head of the department of chemistry at Trinity College, has been granted a sabbatical leave for the year 1930–31. He plans to sail for Europe in July and to spend the greater part of fifteen months in England and on the continent, continuing his investigations on the hydrolysis of nitriles in varying catalytic media. His place will be taken by ALFRED L. PEIKER, a former Trinity student, who is a candidate for his Ph.D. from McGill University this June.

PROFESSOR EVALD L. SKAU, also of the Trinity College chemistry department, has been awarded a Guggenheim Fellowship for study abroad and has therefore been granted a year's leave of absence. (*See* John Simon Guggenheim Memorial Fellowship, THIS JOURNAL, p. 1431).

University of California at Los Angeles. One of the five new buildings on the new 380-acre campus of the University of California is the chemistry building. This structure, which was opened for occupancy in March, 1929, was erected at a cost of $450,000. It is as yet incomplete but houses the offices, classrooms, and equipment for a large number of elementary students, several laboratories for instructors' research, and complete piped and wired services ready for more extended research laboratories in the new wing which is to be built later.

University of Chicago. The first term of the summer quarter of the University of Chicago will open June 16th and close July 22nd; the second term will begin July 23rd and end August 29th. Courses in chemistry will be offered by JULIUS STIEGLITZ, H. I. SCHLESINGER of the chemistry staff, and E. E. REID of The Johns Hopkins University. Professor Reid will give two series of lectures, "Recent Developments in Organic Chemistry" and "The Relations of Properties to Constitution."

According to *Science*, PROFESSOR ALBERT A. MICHELSON has returned to the University of Chicago, his health much improved after two months spent in Bermuda. He intends to remain at Chicago for several months, working in the Ryerson Physical Laboratory, and then plans to go to California to continue his measurements of the velocity of light in a mile-long vacuum tube.

At the Seminar Meeting held April 7th,

DR. MUSKAT discussed some problems of organic chemistry relating to the polarity of alkyl and aryl groups. DR. GANS led the discussion April 21st on "The Raman Effect."

PROFESSOR LINUS PAULING, of the California Institute of Technology, gave an address on Friday, April 18th, on "The Energies of Rotation of Atoms in Solids."

MR. GLEN MOREY has been appointed an instructor in chemistry at the University of Pittsburgh for the last three months of the academic year. Mr. Morey will return in the autumn to the University of Chicago to take charge of the laboratory work in elementary chemistry acting in the capacity of research assistant in inorganic chemistry.

DR. CHARLES A. KRAUS, of Brown University, visited the laboratory April 3rd on his return from an extended western lecture tour.

PROFESSOR T. E. PHIPPS, of the University of Illinois, addressed the Kent Chemical Society, April 25th, on "The Conduction of Electricity in Solid Salts."

DR. and MRS. F. C. KOCH, of the department of physiological chemistry, have returned from their seven months' travel in Europe, during which they spent several weeks at the University of Graz, Austria, and visited laboratories in England and on the continent.

DR. R. G. GUSTAVSON addressed the Chicago Gynecological Society on March 21st on "The Female Sex Hormone."

PROFESSOR T. R. HOGNESS addressed the Minneapolis Section of the A. C. S. on March 19th. His subject was "The Mass Spectrograph in Chemistry."

University of Cincinnati. The Student Branch of American Institute of Chemical Engineers has sponsored a series of popular lectures by members of the faculties of the various colleges. The underlying purpose of these thirty-minute talks was to acquaint the students with the activities and interests of the departments other than chemistry and thus widen the undergraduate viewpoint. The average attendance was two hundred. The course comprised: R. C. GOWDY, "Atomic Structure;" H. B. WHALING, "Mechanism of the Stock Market;" C. H. BEHRE, "Coal, Oil, and the Future;" BRADLEY JONES, "Future Development in Aeronautical Design;" W. H. BUCHER, "Measuring Geological Time;" R. C. McGRANE, "United States Foreign Policy;" G. D. McLAUGHLIN, "Man's First Manufacturing Process, Tanning;" E. I. YOWELL, "Galaxy;" L. H. BRAND, "Linnaeus."

A second series of radio talks on popular chemistry, under the title "Taking the Mist Out of Chemistry," was given this winter by S. B. ARENSON, assistant professor of chemical engineering, under the auspices of the University of Cincinnati and through station WLW at Cincinnati. The titles of the talks were: "Rayon from Sawdust," "The Making of Paper," "The Manufacture of Soap," "Technology of Sugar Making," "Glass from Sand," and "Chemical Research in Industry." As is the custom with all University of Cincinnati programs, copies of all talks were available for those requesting them.

This winter, for the second time, eight informal lectures and discussions on the "Chemistry of Lithography" have been given at the University of Cincinnati for executives, salesmen, and employees in the lithographic industries and for those allied paper and ink industries who are interested in knowing both the how and why of lithographic processes. The subjects discussed were: (1) A general survey of all printing processes; (2) The science of chemistry; (3) The printing surface; (4) Applications of photochemistry to the formation of the image; (5) Transferring and etching; (6) Mutual relationships of plate and ink. Character and composition of lithographic ink; (7) Offset blanket and paper; (8) The printing operations. The course was in charge of SAUL B. ARENSON, assistant professor of chemical engineering of the University of Cincinnati, with the aid of PROFESSOR ROBERT REED, of the Lithographic Technical Foundation, whose research division is

located on the University of Cincinnati's campus. (See "Printing Processes. I," S. B. Arenson, THIS JOURNAL, May, 1930, pp. 1028–36; II, June, 1930, pp. 1263–76).

The University of Cincinnati Section of Sigma Xi, on the recommendation of the departments of chemistry and chemical engineering, has elected to active membership: CLARENCE BAHLMAN, Superintendent of Filtration Plant, Cincinnati Water Works; JOHN W. BOLTON, Chief Chemist and Metallurgist, The Lunkenheimer Co.; DR. I. W. GROTE, Research Chemist, Parke, Davis and Co.; A. J. BERGER, H. S. GREENE, J. H. PAYNE, candidates for Ph.D., June, 1930. Associate membership was conferred on E. T. JOHNSON, H. L. KAHLER, C. J. OPP, E. C. PAYNE, SISTER IGNATIUS SANCHI, C. R. WIMMER, C. POTTER, F. R. RUSSELL, J. WOOLFORD.

The annual banquet and initiation of the University of Cincinnati Section of Sigma Xi was held on April 24th. DR. ARTHUR H. COMPTON, Nobel prize man, professor of physics, University of Chicago, delivered an illustrated lecture on "What Things Are Made of."

FRANCIS E. RAY, instructor in chemistry, Grinnell College, Grinnell, Iowa, has been appointed assistant professor of chemistry, succeeding DR. W. E. BRADT, who was called to Washington State College, Pullman, Washington. Mr. Ray will begin his services at Cincinnati in September.

JOHN H. PAYNE, who is completing his work for the doctorate, has been awarded an Exchange Fellowship by the German Student Exchange and the Institute of International Education. Mr. Payne will spend a year at the University of Munich in the laboratory of PROFESSOR HEINRICH WIELAND.

University of Illinois. PROFESSOR ROGER ADAMS has been chosen to be the Charles E. Dohme University Lecturer at The Johns Hopkins University for the present year. He gave a series of three lectures at The Johns Hopkins on May 1st, 2nd, and 3rd. The purpose of the Dohme lectureship is to promote the development of a more intensive relationship between chemistry, pharmacy, and medicine. The lectureship is offered to scientists from any part of the world: The selection of the lecturer is made by a committee of three made up of PROFESSORS REID, ABEL, and THAYER. The subjects discussed by Dr. Adams were: (1) A survey of various important contributions of organic chemistry to medicine. (2) Use of chaulmoogra oil. Chaulmoogric acid and its constitution. (3) Synthetic homologs and analogs of chaulmoogric acid and their bactericidal action.

The list of scholarships and fellowships granted annually by the University has just been announced. The recipients of the scholarships for the coming year are: B. A. BULL, B.S., Knox College; B. S. FRIEDMAN, B.S., Illinois; B. A. LLOYD, B.S., Illinois; LESTER W. A. MEYER, B.S., Illinois Wesleyan University; W. I. PATTERSON, A.B., Illinois College; and F. A. SMITH, B.S., Illinois. The ranking fellowship given to a graduate student in his last year of work is the Carr Fellowship and it has been granted to L. H. BOCK for the coming year. The du Pont Fellowship has been awarded to J. C. ZIMMER. These two fellowships carry a stipend of $750. Five University Fellowships, of $500 each, were awarded to D. W. DAVIS, B. C. BECKER, C. M. GREER, H. E. PHIPPS, and J. G. STAMPFLI. The second year University Fellowships of $400 each were granted to V. R. HARDY, L. A. MURRAY, and B. G. SMITH.

PROFESSOR T. E. PHIPPS has been awarded a Guggenheim Fellowship, which will permit him to study during the coming year with PROFESSOR OTTO STERN at Hamburg. Dr. Phipps has been granted a leave of absence by the University so that he may accept this Fellowship.

PROFESSOR OTTO STERN, director of the Institute of Physical Chemistry, Hamburg, lectured before the members of the local section on April 22nd and 23rd. "Molecular Rays," "Diffraction of Molecu-

lar Rays," and the "Third Law of Thermodynamics" were the subjects of his lectures.

PROFESSOR L. F. YNTEMA, who has been acting head of the inorganic division during PROFESSOR B. S. HOPKINS' absence, has resigned his position with the university in order to accept a position as professor of chemistry and director of the department of chemistry at Saint Louis University, Saint Louis, Missouri. Dr. Yntema will assume his new duties on September 1st.

"Reality of the Atomic World" was the subject of the address given by DR. G. L. CLARK at the annual Sigma Xi-Phi Beta Kappa convocation given in the Graham Memorial Chapel at Saint Louis University on April 16th. Dr. Clark also spoke at the annual Phi Beta Kappa banquet held the same evening at the Chase Hotel.

DR. ULRICH HEUBAUM, research assistant to PROFESSOR W. A. NOYES, left for Germany on April 25th, to spend his vacation at his home. He will return to this country in July.

DR. N. W. KRASE spoke before the Vanderbilt section at Nashville on April 14th, his subject being "Nitrogen Fixation and Ammonia Production."

DR. N. W. KRASE has accepted a position on the editorial staff of *Chemistry and Metallurgy* for the summer period. He will coöperate with them on the preparation of the material which is to be presented in the September issue on high-pressure reactions, technic, etc.

DR. B. H. MACKAY, who received his degree last year, and who has been doing special research work on the measurement of specific heats of nitrogen at high pressures, will be a member of the staff of the du Pont Ammonia Company next year.

W. M. STANLEY and W. W. MOYER, who received their doctorates at Illinois in 1929, have been granted National Research Fellowships which will enable them to spend next year studying in Europe. Both men will be located at Munich. Dr. Moyer has been a research assistant to PROFESSOR CONANT at Harvard this year, and Dr. Stanley has been working on the leprosy cure problem with Professor Adams at Illinois.

P. W. SELWOOD, who will receive his doctorate in August, 1930, has been awarded a National Research Fellowship which will enable him to study with PROFESSOR C. P. SMYTH at Princeton this coming year.

University of Iowa. The following attended the meeting of the A. C. S. in Atlanta, April 7th to 10th: EDWARD BARTOW, J. N. PEARCE, L. CHAS. RAIFORD, STEPHEN POPOFF, and G. H. COLEMAN.

PROFESSOR EDWARD BARTOW was one of the speakers at the meeting of the Florida Section of the American Water Works Association held at Gainesville, April 10th to 12th.

DR. WILLIAM MCPHERSON, President of the A. C. S., addressed the Iowa Section of the A. C. S. on "Some Reminiscences of Great Teachers of Chemistry," at the special meeting devoted to chemical education held on April 23rd. At the afternoon meeting, papers were given by DR. BEN PETERSON of Coe College, Cedar Rapids, and MR. CHARLES B. YAGER of the University High School. The round-table discussion was conducted by PROFESSOR L. P. SHERMAN of Grinnell College

The following students in the chemistry department have been awarded Lydia Roberts Fellowships at Columbia University for the year 1930–31: MARTHA POTGIETER (biochemistry and nutrition) and MARLIN E. FOGLE (chemical engineering).

Elections to Sigma Xi in the chemistry department are: Active membership: CHARLES B. YAGER, G. MERVIN MCNULTY, ROBERT RIEDER. Associate membership: JESSE W. CAVETT, D. S. DEDRICK, E. L. HILL, MILDRED A. HOOPER, J. G. LICHTY, DUANE C. MCCANN, WALTER G. MEYER, GLEN R. MILLER, FRED W. OBERST, GUSTAV E. OSTROM, LEE D. OUGH, CECIL E. SCOTT, VERDA I. WIRTH, JOEL H. HIRSCH, GERALD O. INMAN, PATRICK H. DOUGHERTY.

PROFESSOR HARRY F. LEWIS, head of the department of chemistry at Ohio

Wesleyan University, will be a lecturer in organic chemistry during the first summer session.

University of Maryland. On April 10th, DR. C. FRANCIS JENKINS gave an illustrated lecture on the development of "Radio-Vision."

On April 14th, DR. J. E. MILLS, former director of research at Edgewood Arsenal and now with the National Research Council, gave a talk on "Molecular Attraction."

DR. HENRY G. KNIGHT, of the Bureau of Chemistry and Soils, U. S. Department of Agriculture, gave a talk on "Governmental Research" at the initiation banquet of Sigma Xi on April 30th. DR. W. W. SKINNER, of the same bureau, also addressed the meeting.

University of Missouri. PROFESSORS H. E. FRENCH, A. E. STEARN, and M. V. DOVER, of the department of chemistry, University of Missouri, attended the Spring Meeting of the A. C. S. held in Atlanta, Georgia.

University of Southern California. According to *Science*, DR. WILDER D. BANCROFT, of Cornell University, will give the dedicatory address on "Modern Science" at the dedication of the new hall of science at the University of Southern California on June 6th during the semi-centennial celebration.

University of Utah. DR. CHARLES A. KRAUS, professor of chemistry at Brown University, spoke before the Northwest Utah branch of the A. C. S. Thursday, March 13th, at the University of Utah. The subject of his lecture was "Solutions of Metals and Metallic Substances in Liquid Ammonia." Dr. Kraus has effectively studied the properties and the atomic constitution of a number of the metallic elements by employing liquid ammonia as a solvent medium.

Two hours preceding the lecture a banquet was given at the Hotel Newhouse in honor of Dr. Kraus, jointly by the American Chemical Society and the Alpha Xi Chapter of Alpha Chi Sigma, professional chemical fraternity. Between courses, DR. THOMAS B. BRIGHTON, of the University of Utah, introduced Dr. Kraus, who urged the student of chemistry to seek a broad chemical education, and also to acquire a knowledge of general physics and higher mathematics. He pointed out that modern industrial chemistry places a premium upon personality and the ability to coöperate with fellow workers, the development of original ideas pertaining to the industrial processes, and correct, effective language to convey the ideas to others.

Dr. Kraus attended the University of Kansas and received his bachelor's degree in 1898. The next few years were spent in studying at Kansas and teaching in California. He received his master's degree from the Massachusetts Institute of Technology in 1908. From 1914 to 1924 he was professor of chemistry at Clark University. Since then he has been professor of chemistry at Brown University.

University of Virginia. Nearly two million dollars in gifts and bequests to the University of Virginia during the past year was acknowledged by PRESIDENT ALDERMAN at the Founder's Day exercises held on April 12th. Included in the announced total is the sum of $140,000 from the estate of the late John Blackwell Cobb, donor of the Cobb Chemical Laboratory built in 1916. The major portion of the additional bequest will be devoted to the construction of a new wing providing increased facilities for research, less crowded undergraduate laboratory accommodations, and adequate space for the library which has outgrown present quarters.

Under date of April 15th the School of Chemistry announced through DR. ARTHUR F. BENTON, acting chairman, appointments to paid research positions for the coming year as follows: thirteen teaching fellows; five research fellows;

three research associates. In the Division of Alkaloid Research, headed by DR. L. F. SMALL and supported by the National Research Council, appointments have been made to one research professorship, two research associateships, three research fellowships.

DR. WILLIAM S. CALCOTT, associate director of the Jackson Laboratory, E. I. du Pont de Nemours and Company, and a graduate in chemical engineering from this University in 1913, addressed the Chemical Engineering Society and guests on April 14th on the rôle of the chemical engineer in carrying a chemical reaction from the laboratory scale through the semi-works stage to large-scale plant production.

PROFESSORS BENTON, YOE, LUTZ, HITCHCOCK, SPENCER, MARKHAM, and MESSRS. HILL, DRAKE, and BODE represented the department at the Atlanta Meeting.

Washington University. PROFESSOR L. MCMASTER and PROFESSOR JOHN H. GARDNER, of Washington University, St. Louis, Missouri, attended the recent meeting of the A. C. S. at Atlanta, Georgia.

PROFESSOR CHARLES A. KRAUS, of the department of chemistry at Brown University, visited the University on March 3. In the evening he gave a lecture entitled "The Boundary between Organic and Inorganic Chemistry," before the St. Louis Section of the A. C. S.

DR. GEORGE L. CLARKE, of the department of chemistry, University of Illinois, visited the department on April 16th and delivered the address before the annual meeting of Phi Beta Kappa and Sigma Xi. In the evening he was the guest of honor at a dinner given by the two societies, presided over by PROFESSOR L. MCMASTER.

MR. CHARLES A. NAYLOR, instructor in chemistry, has resigned his position in order to enter on the department of chemistry fellowship next academic year.

During the week of April 14th the Senior Chemical Engineering Class made the annual inspection trips under the direction of PROFESSOR L. E. STOUT. They visited a number of industrial plants in Illinois and Missouri.

Washington and Lee University. On Saturday evening, March 29th, the Southwest Virginia Chemists Club met in Lexington under the auspices of the chemistry department of Washington and Lee University and the Gamma Sigma Epsilon Chemical Fraternity. Following a dinner at the Robert E. Lee Hotel, DR. HARRISON E. HOWE, editor of *Industrial and Engineering Chemistry*, spoke on "The New Competition in Industry," illustrating his lecture with a number of examples of the newer products of chemical research that have created this competition. Following the address by Dr. Howe, DR. JESSE HOLMES, of Swarthmore, spoke on "Humanizing Industry."

The Lind Prize in Chemistry for 1930 has been awarded to EUGENE JOHNSON of Huntington, W. Va. This prize is a membership in the American Chemical Society, offered by SAMUEL COLVILLE LIND, B.A., Washington and Lee, '99, to that candidate for the B.S. in chemistry having the best standing at the end of his third or fourth year in chemistry.

Wesleyan University. As substitute councilor for the Connecticut Valley Section, A. C. S., PROFESSOR G. ALBERT HILL attended the Atlanta Meeting of the Council of the Society. He gave a paper on "Laboratory Equipment and Laboratory Instruction" before the Division of Chemical Education.

The Connecticut Valley Section recently met at Wesleyan University and was addressed by PROFESSOR J. B. CONANT, of Harvard University, on "Oxidation."

Western Union College. B. H. HANDORF, of Western Union College, has been awarded a scholarship in chemistry at the University of Nebraska for next year.

Projects are being tried out for general chemistry and a display is scheduled for the last week in May.

West Virginia Academy of Science. The seventh annual meeting of the West Virginia Academy of Science was held at Potomac State School, Keyser, West Virginia, April 25–26, 1930. The following chemistry papers were presented: WALTER A. KOEHLER: "The Whiteware Industry of West Virginia in Its Relation to Chemistry." B. B. KAPLAN: "Mineral Wastes." C. A. JACOBSON: "The Need of Standardizing Chemical Nomenclature." EARL C. H. DAVIES: "Rhythmic Evaporation of Orange II and Fast Red B."

Wittenberg College. The first annual chemistry contest for high-school seniors is being conducted during May by Wittenberg College. It is sponsored by the Alpha Iota chapter of Theta Chi Delta, honorary chemistry fraternity.

One senior student from each high school in Ohio is competing in this event. It is expected that there will be about 125 contestants.

The prizes are as follows: First prize—$250.00; second prize—$150.00; third prize—$100.00; fourth prize—$50.00; fifth prize—$50.00.

Woman's College of Alabama. The chemistry department announces the appointment of MISS LEONA MAE KALEY as assistant professor of chemistry. Miss Kaley is at present instructor in chemistry at Syracuse University. She will assume her new duties in September, 1930.

Indiana Section, A. C. S. *See* **Franklin College.**

Illinois Section, A. C. S. *See* **University of Illinois.**

Iowa Section, A. C. S. *See* **Cornell College.**

Kansas Section, A. C. S. *See* **Kansas State Agricultural College.**

Michigan State College Section, A. C. S. *See* **Ohio State University.**

Northeastern Section, A. C. S. *See* **Boston University.**

Northwest Utah Section, A. C. S. *See* **University of Utah.**

Rhode Island Section, A. C. S. *See* **Brown University.**

St. Louis Section, A. C. S. *See* **Washington University.**

History of Alcohol and the Term "Gas." In the *Chemiker-Zeitung* (November 9, 1929), Prof. E. O. von Lippmann discusses the history of alcohol and the origin of the word "gas." The view of the scholar, Treuer (1725), that the Arabians had founded the art of distillation about 800 A.D. rests on an error; thus, that Treuer did not appear to be greatly concerned as to when and by whom the preparation of spirit of wine was discovered; the views that the knowledge of the distillation of water was spread over Europe in 1200 and that of wine in 1300 are also inconclusive and untenable, as Prof. Lippmann has elsewhere shown. Dr. Lippmann does not agree with Dr. Darmstaedter's view about the term "gas," and he thinks that too much weight is attributed to the one sentence in which Paracelsus used this expression, in spite of the many and numerous occasions in which he employed the word "chaos" synonymously with air. Further, van Helmont is considered to have appropriated the term "gas" from Paracelsus, while etymological reasons show that "chaos" would at once be changed to "gas" in the Dutch language. Moreover, van Helmont regarded the word "Blas" as his own, while actually he had obtained it as well from Paracelsus.—*Chem. & Ind.*

Recent Books

A Brief Introduction to the Use of Beilstein's Handbuch der Organischen Chemie. ERNEST HAMLIN HUNTRESS, Ph.D., assistant professor of organic chemistry, Massachusetts Institute of Technology, Cambridge, Mass. John Wiley and Sons, Inc., New York City, 1930. viii + 35 pp. 15 × 23 cm. $1.00.

This little pamphlet, based on part of a course of lectures given at the Massachusetts Institute of Technology for students specializing in chemistry, is "a brief explanation of the method of classification of organic compounds used in the fourth edition of Beilstein's Handbuch der Organischen Chemie." It constitutes the most complete exposition to be found in English of the necessarily rather involved Prager-Jacobson classification system.

Chapter I, devoted to an explanation of the scope of the Handbuch, is followed by four chapters setting forth the various rules which govern the system; and the final chapter contains illustrations of the method of finding a particular compound, given its structural formula, provided, of course, that the substance is included in the published volumes. In this final chapter is to be found also a survey of the volumes of Beilstein already published, with publication dates and contents.

A classification system which is to include 200,000 entries, the number contemplated for the fourth edition of Beilstein, is necessarily very complex, but Dr. Huntress has set forth in this work in a clear and logical fashion the various rules of this complicated system. Furthermore there are few errors in formulas, tables, or text.

For the student specializing in other than organic chemistry, the pamphlet will be of little interest, for such a student will probably prefer to waste a little time on those rare occasions when he consults Beilstein, rather than to try to master the complicated Prager-Jacobson classification method. To the student of organic chemistry the volume is recommended for thoughtful consideration and study. Time spent in mastering the classification system will be saved many times over through increased facility in the use of Beilstein.

The pamphlet is bound with a paper cover, but print and paper are good. The work is a valuable contribution, clearly presenting a difficult and complicated subject.

NATHAN L. DRAKE

UNIVERSITY OF MARYLAND
COLLEGE PARK, MD.

Atoms, Molecules, and Quanta. ARTHUR EDWARD RUARK, Ph.D., Physicist, Mellon Institute of Industrial Research, lecturer in physics at the University of Pittsburgh, and HAROLD CLAYTON UREY, Ph.D., associate professor of chemistry at Columbia University. *International Series in Physics.* F. K. RICHTMYER, *Consulting Editor.* McGraw-Hill Book Company, Inc., New York City, 1930. xviii + 790 pp. 15 × 23 cm. $7.00.

The appearance of this treatise on the structure of matter is truly a milestone in the progress of American chemical literature. In the words of its authors, "This book was written with a double purpose. It is intended to serve the needs of those who approach the fascinating study of atomic and molecular structure for the first time, and portions of it are therefore written in full and simple style for these newcomers. It also seeks to serve workers in the field with an up-to-date account of the laws of quantum theory, and with a general account of important experimental researches in the field." Any one at all familiar with the manifold developments in the field of atomic structure will agree that the authors set themselves a

gigantic task. That they have fulfilled it so well is not only a tribute to their own ability, but also to the standards of American scientific education which have produced men that could accomplish such a monumental work. As a first-rate, thoroughly sound, comprehensive treatise, this book is the equal, if not the superior, of any similar work which has been produced abroad.

Considering the proportions of the field which the authors have covered, they have succeeded remarkably well in the first part of their double purpose, namely, to make the book readable for beginners in atomic physics. The first few chapters and the first parts of the later chapters, which deal particularly with the experimental basis of our present concepts, are essentially non-mathematical and understandable for one with the ordinary undergraduate college training in the subject. Some of the later chapters, however, will be apt to awe any one but a specialist in the subject. This transition is indicated by the number of mathematical equation per page, the ratio being 0.94 equation per page in the first chapter, 1.7 in chapter two, approaching, as the book progresses, a value which to the ordinary reader seems pretty close to infinity. However, there is such a completeness of proof and clearness of presentation that one may proceed through the pages of this book with a reasonable amount of study and see the unfolding of our physical concepts with considerable understanding even as far as such abstruse topics as the wave and matrix mechanics.

The above description should indicate fairly well the rôle which this book will play in chemical education. The reader who expects a popular exposition arranged primarily for the purpose of enticing him to read further will be disappointed. Its greatest use will probably be for those who have completed or are just completing a college course in chemistry or physics. With such a background and a good knowledge of calculus this book should prove really exciting. Besides this it is well qualified to stand for several years as a standard of reference for specialists in a number of the fields which it touches.

DONALD H. ANDREWS
THE JOHNS HOPKINS UNIVERSITY
BALTIMORE, MARYLAND

The Chemistry of the Colloidal State. JOHN C. WARE, Sc.M., Ph.D., associate professor of chemistry, New York University. John Wiley and Sons, Inc., New York City, 1930. xiv + 313 pp. 96 figures. 15 × 22 cm. $4.50.

This volume is a textbook intended "to present the fundamentals of colloid chemistry as they are disclosed by an analysis of the material available at this time and not in accordance with the facts of twenty years ago when the subject was on the threshold of a period of very intensive scientific research." The chapter headings are: The units of a colloidal solution; sedimentation; interfacial phenomena; turbidity and colloidal suspensions; colloidal suspensions and color; motion in colloidal suspensions; the electrical character of interfacial phenomena; the preparation of substances in the colloidal state; the precipitation of substances in the colloidal state; water in combination—viscosity and plasticity of colloidal suspensions; emulsions; gels; silica gel and its uses in adsorption; catalysis by contact agents.

There is undoubtedly a wide difference of opinion as to what should be included in a 300-page introductory textbook on colloid chemistry. The author of this volume has made a very satisfactory choice of subjects and in most cases has presented the material in a manner that will be helpful alike to teacher and pupil. The ninety-six cuts and diagrams are especially good and contribute materially to the usefulness of the book as a text.

While welcoming a book on colloids that is designed primarily for classroom use teachers of colloid chemistry will find it desirable, if not essential, to supplement the material included in the text. On this account and for the reason that the volume

will be used chiefly by upper classmen and graduate students, the bibliography is altogether inadequate. Moreover, the book comes far short of being brought down to date in certain cases. For example, the section on the precipitation of colloids might have been written twenty years ago. There are errors, both typographical and otherwise, which should be eliminated from the next edition.

HARRY B. WEISER

THE RICE INSTITUTE
HOUSTON, TEXAS

Colloid Chemistry: Principles and Applications. JEROME ALEXANDER, M.Sc., consulting chemist and chemical engineer. D. Van Nostrand Co., Inc., 1929. Third edition. x + 270 pp. 15 × 23 cm. $3.00.

The first chapter starts out as an introductory one but has a paragraph on wave mechanics, apparently because a material corpuscle is involved. The second chapter starts with material units and includes a table of isotopes, the diameter of the galaxy, Sörensen's pH, and residual affinities. The reviewer finds it difficult to believe, p. 28, that the decreased efficiency of enzymes, after the temperature exceeds a certain value, is due to the average molecular velocity reaching so high a value that the enzyme cannot cope with it.

Chapter III deals with the classification of colloids but does not include the interlacing systems to which many jellies belong. Chapter IV discusses the consequences of subdivision, the most important of which is that the total surface increases. Chapter V gives an elementary and much simplified description of the ultramicroscope. In Chapter VI we find the general properties of colloids.

The remaining eight chapters deal with practical applications of colloid chemistry, the special topics being: astronomy; meteorology; smokes, fogs, and dusts; perfumes; geology; mineralogy; gems; agriculture; clays; ceramics and refractories; flotation; dyeing; shower-proofing fabrics; nitrocellulose and its products; celluloid; explosives; paints, pigments, varnishes; emulsions; soaps; lubrication; colloidal fuel; petroleum; asphalt; fire foam; insecticides; filtration; sewage disposal; photography; brewing; tanning; paper; rubber; foods and their preparation; baking; milk; ice cream; confectionery; gelatin and glue; glasses; metals and alloys; the time factor; iron and steel; steel; stepped transformation in steel; standard heat treatment terms; tin - lead alloys; zinc - copper alloys; bronzes; amorphous *vs.* colloidal theory; electrodeposition of metals; boiler scale; cement, mortar, and plaster; chemical analysis; pharmacy and therapeutics; antiseptics and bacteriology; biology and medicine; enzymes; cytology; growth; evolution; physiology and pathology; capillary circulation; psychiatry; anaphylaxis and immunity; healing of wounds; digestion; absorption, secretion, excretion; diagnosis; chemotherapy and colloid therapy; serum therapy; plants; bio-electric currents; some physico-chemical aspects of life; mutation and evolution.

This is highly impressive on paper but there is not much leeway when one tries to treat some ninety topics in 158 medium-sized pages. It is a hopeless task, for instance, to treat ceramics, p. 109, in two short paragraphs. When so much has to be left out, it seems a pity to include anything that is wrong; but the color of the ruby is due to dissolved chromic oxide and not to dispersed ferric oxide, p. 97. One wonders whether the author knows what the Cottrell process is, p. 89. When one says high-tension current, one does not ordinarily mean direct current. Why not?

The book is entertaining reading and should be read for that purpose only.

WILDER D. BANCROFT

CORNELL UNIVERSITY
ITHACA, NEW YORK

Bacterial Metabolism. MARJORY STEPHENSON, M.A., associate of Newnham College, Cambridge, member of the scientific staff of the Medical Research

Council. Monograph on Biochemistry. Longmans, Green & Co., New York City, 1930. xi + 320 pp. 34 figs. 85 tables. 15.5 × 24.5 cm. $7.00.

For the first time the varied and manifold chemical processes which underlie the life and growth of bacteria have been brought together within the limits of a single volume.

A brief introduction to the early views of fermentation is followed by a presentation of the energy relations based on the work of Rubner and his school; the biological significance of fermentation is considered in the light of Pasteur's views and the more recent work of Meyerhof. Chapter III on Respiration is an exposition of the theory of hydrogen transfer (Wieland) as elaborated largely by Quastel, the significance and use of oxidation-reduction potentials, the rôle of activators of oxygen and anaerobiosis. Chapter IV on Growth and Nutrition, dealing with reproduction and the nutritional requirements of bacteria, is followed by chapters on the breakdown of carbohydrates and proteins. In these sections in particular, as well as throughout the book, an immense amount of material has been most ably organized. The Synthesis of Polysaccharides, Nitrogen Fixation, and Autotrophic Bacteria form the subject matter of the remaining chapters; an appendix contains the important media used for the different types of organisms and there is an alphabetical bibliography of 32 pages.

This book will be eagerly welcomed by biologists and chemists alike for its clear and critical exposition of the fundamental chemistry and physics of bacterial life.

The author gratefully acknowledges her indebtedness to Professor Sir Frederick Hopkins "at whose suggestion the book was written and to whose influence alone I owe the incentive to think on biochemical matters."

H. A. MATTILL

STATE UNIVERSITY OF IOWA
IOWA CITY, IOWA

Steam and Gas Engineering. A Text Covering Power-Generating Apparatus Utilizing Energy Released by the Combustion of Fuels. THOMAS E. BUTTERFIELD, M.E., C.E., professor of heat power engineering at Lehigh University, Member A.S.M.E. First edition, D. Van Nostrand Co., Inc., New York City, 1929. xv + 481 pp. 16.5 × 23.5 cm. 335 figures. $4.50.

This book gives teachers of physics and chemistry encouragement. They are given little opportunity to observe the effectiveness of their teaching on the whole to the great mass of students who go out from under their care with none too sanguine notions that anything very real has been accomplished for them. The author states: "Engineering students usually have a good preparatory knowledge of physics and chemistry when they take up the study of this subject. They are well able to perform the computations required to find air, gas, and fuel quantities and readily learn how to calculate efficiencies and losses associated with the combustion of fuel in power plants."

Teachers of science quite naturally continue to question the effectiveness of their teaching. They should continue to doubt their own conclusions as to the soundness of the basis of their work, thereby seeking improvement. Testimony of experienced teachers in entirely unrelated fields, such as that of this teacher of engineering, shows that the foundation work of the universities and colleges in education carries with it an unknown effectiveness that should stimulate the teacher's faith in education and his desire for constant improvement, not for their own sake as teachers, but for that of the great group of students who will never know themselves from whence they derive such clearness of ideas and thinking as they acquire through the years.

The author presents "an introductory text for engineering students and for engineers dealing with the utilization of fuels for the development of power." "Thermodynamics is the backbone of the text." The plan of the text calls for alternate discussions of theory and practice.

Much mathematical formulation is eliminated and whenever possible scientific principles or natural laws have been expressed in words and illustrated by concrete examples. Simple formulas are given for practical calculations, covering heating values of fuels, air requirements for combustion, the use of the steam tables, and engine power and efficiency.

In a single volume every type of power equipment is described and illustrated with regard to both design and operation. Special emphasis is laid upon up-to-date modern practice, including most recent information on pulverized coal, heavy oil engines, accessories for internal combustion engines, modern turbine engineering and high-pressure development in present-day power plants. Although the internal combustion engine supplies most of the mechanical energy in industry (the author was formerly chief engineer of the Otto Engine Works), nevertheless large sizes developing high economy have made the steam power plant the accepted unit in large central stations for both manufacturing plants and public utilities, steam engineering, therefore, still possesses the greater interest and more space is devoted to it. The ground covered is Fuels, Combustion Calculations, Boiler Furnaces, Grates and Stokers, Pulverized Coal, Heat and Work, Properties of Steam, The Steam Boiler, Boiler Auxiliaries, Laws of Gases, Gas Cycles, Steam Cycles, The Simple Steam Engine, The Corliss Engine, The Uniflow Engine, Steam Diagrams, Valve Gears, Governing Steam Engines, Steam Turbines, Nozzle Calculations, Blade Calculations, Gas Producers, Internal Combustion Engines, Gas and Gasoline Engine Types, and Heavy Oil Engines.

The chapter on Fuels introduces the whole work and develops the important engineering principle that a knowledge of the nature and combustion of fuels determines the design of the apparatus for their combustion. These very characteristics teach the students also that power-plant requirements vary in type with different regions due to the variation in fuel economics in different localities. This factor also shows the necessity of spending time and money in raising thermodynamic efficiency in power-plant apparatus. The author could have added also chemical and chemical engineering studies on the nature of the fuels themselves. Much labor has been expended by the author upon giving to the student an opportunity to correlate theory with practice, becoming familiar with the construction and methods of operation of various kinds of apparatus used in connection with the developing of power from heat energy, describing various kinds of engines, boilers, gas producers, and auxiliary apparatus. To this material the individual teacher will add his own experience. The book is particularly well illustrated with drawings, cuts, diagrams, and curves of equipment, as well as sectional views of assembled and unassembled apparatus. One of the excellent features of the text is the thorough series of examples when such things as the properties of steam are being discussed with complete solution of the problems involved. In addition a series of problems are added at the close of the various chapters where the problems will make the text clear, such as: Fuels, Combustion, Boiler Furnaces, Grates and Stokers, Heat and Work, Properties of Steam, Auxiliary Apparatus for the Steam Boiler, Laws of Gases, Gas Cycles, Steam Cycles, Steam Diagrams and Power of Simple and Compound Engines, Governing Steam Engines, Nozzle Calculations, Blade Calculations, Internal-Combustion Engines. From these teachers of physics and chemistry could get valuable help in devising their illustrative problems. Another excellent feature is the thorough list of reference to engineering literature as well as books and pamphlets.

The author appears to have succeeded in large measure in helping to a firmer grasp of the relation between thermodynamic conceptions and practical application. The students should permanently

retain the essentials. The author has accomplished his purpose in making the subject easy to acquire and assimilate, and has followed the plan throughout for alternate discussion of theory and practice. The apparent lack of coherence in the development of the theory of thermodynamics has been eliminated by an adequate number of thorough reviews at the beginnings of such chapters where there is a continuation of the theory of thermodynamics in its applications. The book is commendable to the chemist or the chemical engineer in the field, as a reference book, in which the practical items of steam and gas engineering are adequately correlated with thermodynamics in a manner which can be easily assimilated. From the standpoint of academic chemical education there are no applications beyond the chapters dealing with fuels and their combustion. Every scientific man going into technical work in industry should be aware of power engineering as the basis of all engineering and industry. In every kind of plant, power appears as an important item in cost and operation. To the engineer this book is an aid to development of power cost economics and operating improvement.

The paper used is good. The surface is not too heavily calendered to interfere with intensive study. The book's size is unusually compact. The binding is garnet buckram. All in all, the book is physically well executed as well as written in simple and understandable language, covering both the theory involved and practices in industry.

JAMES R. WITHROW

OHIO STATE UNIVERSITY
COLUMBUS, OHIO

The Elements of Fractional Distillation. CLARK SHOVE ROBINSON, associate professor of chemical engineering, Mass. Institute of Technology, Cambridge, Mass. Second edition. McGraw-Hill Book Company, Inc., 370 Seventh Avenue, New York City, 1930. xii + 255 pp. 6 tables and 61 figures. 14 × 20.5 cm. $3.00.

Contrary to public opinion, distillation as a chemical engineering unit process is extremely important in other fields besides alcohol. Professor Robinson, in the second edition of his famous book entitled, "The Elements of Fractional Distillation," brings out very clearly the importance of distillation in petroleum refining.

There is no question but that Professor Robinson's book is still the outstanding book on this subject written in the English language. The elementary physical chemistry involved in this unit process of chemical engineering is well described, as it was in the first edition. Some material of a theoretical nature has been added; for example, the famous McCabe-Thiele method of calculating the number of plates necessary in a fractionating column. The differential method as developed by Professor W. K. Lewis is also described as in the previous edition. The author has been very careful to maintain a scientific aspect to the general problem. He has given considerable practical data; however, he might be criticized by the engineer for not giving quite enough of the so-called "rule-of-thumb" methods used commonly in the design of columns and stills. These practical methods would not only be extremely interesting but would not destroy in any way the high standard of the theoretical work described in the book.

The book may be said to be divided into four parts. The first part involves simple physical chemistry, such as the phase rule, the gas laws and their application to distillation. The second part covers the fundamental laws involved in distillation and fractionation. The third part describes a method for the design of a continuous still, including the fractionating columns and the condensers. The last section of the book gives examples of continuous distillation and a portion of this subject which involves the fractionation of hydrocarbon mixtures is of special interest.

There is no question that as an ele-

mentary text on distillation, Professor Robinson's book is still the finest ever published.

D. B. KEYES

UNIVERSITY OF ILLINOIS
URBANA, ILLINOIS

Pharmaceutical Mathematics. EDWARD SPEASE, Ph.C., B.S., professor of pharmacy and dean of the school of pharmacy, Western Reserve University, Cleveland, Ohio. McGraw-Hill Book Co., Inc., New York City, 1930. xii + 126 pp. 20 × 14 cm. $1.75.

This book is intended for use as a textbook in teaching the mathematics of pharmacy to students of pharmacy and nursing. The principal topics considered are weights and measures, percentage, dosage, specific gravity, temperature scales, dilution, alligation, simple chemical problems and commercial problems, all from a strictly pharmaceutical standpoint.

The book is a brief one, because the mathematics of pharmacy consists only of special applications of certain topics of arithmetic, and there is little or nothing of the rather abstruse mathematics which is used in physics and physical chemistry. Instead of this, we find that pharmaceutical arithmetic is intensely "practical," in that the student is shown how to solve problems, with no attention paid to the rigorous demonstration of reasons underlying the methods used.

The author appears to have done his work well, and the book is attractively printed and bound. It should be interesting and useful to students of chemistry who are contemplating the subsequent study of pharmacy or nursing.

THEODORE J. BRADLEY

MASSACHUSETTS COLLEGE OF PHARMACY
BOSTON, MASSACHUSETTS

Annual Reports on the Progress of Chemistry for 1929. Volume XXVI. THE CHEMICAL SOCIETY, LONDON, ENGLAND. Richard Clay & Sons, Ltd., Bungay, Suffolk, England, 1930. 336 pp. 13.5 × 20.5 cm. 10s. 6d. net (postage 6d. extra).

This annual volume contains a review of the progress of chemistry during the year 1929 with valuable references to the original literature. The fields covered by specialists are: *General and Physical Chemistry*, H. HUNTER (pp. 11–33); *Inorganic Chemistry*, H. BASSETT (pp. 34–73); *Organic Chemistry*, Part I, Aliphatic Division, W. N. HAWORTH and E. L. HIRST (pp. 74–114), Part II, Homocyclic Division, G. M. BENNETT (pp. 115–51), Part III, Heterocyclic Division, S. G. P. PLANT (pp. 152–84); *Analytical Chemistry*, B. A. ELLIS and J. J. FOX (pp. 185–204); *Biochemistry*, A. C. CHIBNALL and J. PRYDE (pp. 205–52); *Mineralogical Chemistry* (1928–29), L. J. SPENCER (pp. 253–74); *Crystallography*, J. D. BERNAL and W. A. WOOSTER (pp. 275–307).

BULLETINS

Experimental Research in Education. WALTER S. MUNROE, Director, and MAX D. ENGELHART, Assistant, Bureau of Educational Research, University of Illinois. *Univ. of Illinois Bulletin* No. 48. Univ. of Illinois, Urbana, Ill., 1930. 105 pp. 15.5 × 23 cm. $0.50.

This bulletin describes in some detail the procedure of controlled experimentation.

Ajax Northrup Electric Furnaces. *Bulletin* No. 6. THE AJAX ELECTROTHERMIC CORPORATION, Ajax Park, Trenton, N. J., 1930. 12 pp. 20.5 × 27 cm. Free.

In this bulletin are described various installations of Ajax-Northrup coreless or high-frequency induction furnaces.

Common sense is generally a guide that never deceives. One must not hesitate to fight ideas that seem contrary to it, even when professed by eminent men.—GEORGES CLAUDE

AN INDEX TO BOOK REVIEWS IN 1929

LEOPOLD SCHEFLAN, LONG ISLAND UNIVERSITY, BROOKLYN, NEW YORK

The following index has been compiled for two reasons. 1. To list the most important recently published books of interest to chemists. 2. To give references where information about these books may be obtained. In general references have been given for only those books which actually have been reviewed. An exception was made in the case of educational books because very few of them have been discussed critically in the standard chemical journals.

The index consists of two parts: (1) Subject Index and (2) Author Index. The Subject Index has been subdivided into the following sections.

A: Analytical
B: Biological
C: General, Inorganic, and Physical
D: Engineering Chemistry and Chemical Engineering
E: Historical
F: Organic
G: Popular
H: Bibliographical
I: Educational
J: Physics
K: Miscellaneous Texts

The Author Index follows the Subject Index and consists of an alphabetical list of the authors, each followed by the section letter, in boldface type, and item number in the Subject Index where the publication of the author may be found. For example:

ABDERHALDEN, E., **B**8 means that in Section **B: Biological,** item 8, will be found information, including title and references to reviews, concerning a publication of Abderhalden's.

The same book may be listed more than once in the same section or in several sections. In no case, however, are the complete title, the author's name, and the references given more than once. The cross references, which are printed in italics, are abbreviated and refer the reader to the complete reference.

The following journals have been consulted in the compilation of the index, the numbers in italics being used in the index to designate the corresponding journal.

(*1*) THIS JOURNAL, vol. **6.**
(*2*) *Journal of the American Chemical Society,* vol. **51.**
(*3*) *Journal of Physical Chemistry,* vol. **33.**
(*4*) *Industrial and Engineering Chemistry,* vol. **21.**
(*5*) *Chemical and Metallurgical Engineering,* vol. **36.**
(*6*) *Journal of the Association of Official Agricultural Chemists,* vol. **12.**

The abbreviations of the months used are: Ja, F, Mr, Ap, My, Je, Jy, Ag, S, O, N, D.

The following examples will indicate the form in which the items are indexed.

B: Biological

8 Biologischen Arbeitsmethoden, Handbuch der—(Handbook of Biological Methods), Vol. I, Part II, second half, E. ABDERHALDEN, (*2*)D3685, (*3*)Ja160.
9 *Biology and Colloid Chemistry—See* **C**11.

In item 8 the (*2*) refers to the *Journal of the American Chemical Society*, D to the December, 1929, issue of that journal, and the 3685 is the page number. Likewise, a review of Abderhalden's book appears in (*3*), the *Journal of Physical Chemistry*, in the January, 1929, issue, on page 160. In item 9, the **C**11 refers to Section **C: General, Inorganic, and Physical,** item 11, which happens to be in this case

11 Applied Colloid Chemistry, Theoretical and—, Vol. II, Biology and Medicine, J. ALEXANDER, (*3*)Ag1273, (*4*)F194, (*5*)Mr167.

It is planned to publish such an index every year. The compiler will appreciate greatly any criticism, corrections, and suggestions for improvement.

SUBJECT INDEX

A: Analytical

1 *Alkaloids—See* **A**2.
2 Allan's Commercial Organic Analysis, 5th ed., Vol. VII, Vegetable Alkaloids, C. A. MITCHELL, (*4*)Jy709, (*5*)Jy432.
3 Calculations, Chemical, 2nd ed., J. S. LONG AND H. V. ANDERSON, (*1*)Ja177, (*4*)Ja94.
4 Calculations in Quantitative Chemical Analysis, J. A. WILKINSON, (*4*)Ja93.
5 *Chemical Calculations—See* **A**3, **C**167, and **K**5.
6 *Electrolytes—See* **A**33.
7 Gesteinsanalyse, Anleitung zur Chemischen—(Directions for the Chemical Analysis of Ores), J. JACOB, (*2*)Mr955.
8 Identification and Properties of the Common Metals and Non-Metals, J. E. BELCHER AND J. C. COLBERT, (*1*)My1006.
9 Inorganic Analysis with Especial Reference to the Analysis of Metals, Minerals, and Rocks, Applied—, W. F. HILLEBRAND AND G. E. F. LUNDELL, (*5*)D744.
10 Lumineszens-Analyse im Filtrierten Ultravioletten Licht. (Analysis by Means of Luminescence in Filtered Ultra-Violet Light), P. W. DANCKWORTT, (*2*) Mr958, (*4*) Mr294.
11 Do. 2nd ed., P. W. DANCKWORTT, (*2*)D3681, (*4*)D1304.
12 Medicine, Qualitative Analysis for Students of Pharmacy and—, C. B. JORDAN, (*1*)Mr593.
13 *Metals and Non-Metals—See* **A**8.
14 *Metals—See* **A**9.
15 *Minerals—See* **A**7.
16 *Minerals—See* **A**9.
17 Micro-Methods, Practical Chemistry by—, E. C. GREY, (*1*)S1600.
18 Mikromethoden zur automatischen Verbrennung Organischer Substanzen und Ebullioskopischen Molekulargewichtsbestimmung, Halb—(Semi-Micro Methods for the Combustion of Organic Substances and Boiling-Point Methods for the Determination of Molecular Weights), E. SUCHARDA AND B. BOBRANSKI, (*4*)My514.
19 *Molecular Weights—See* **A**18.

20 Nephelometry. Photometric Chemical Analysis. Vol. II, J. H. YOE AND H. KLEINMANN, (*1*)Jy1370, (*2*)Ag2593, (*3*)Ag1280, (*4*)My512, (*6*)N443.
21 *Non-Metals—See* **A8**.
22 *Organic Analysis—See* **A2**.
23 *Organic Combustion—See* **A18**.
24 Organischen, Qualitativen Analyse, Anleitung zur— (Directions for Qualitative Organic Analysis), H. STAUDINGER AND W. FROST, (*4*)N1151.
25 *Pharmacy—See* **A12**.
26 *Photometric Chemical Analysis—See* **A20**.
27 Qualitative Analysis, J. S. LONG, D. S. CHAMBERLAIN, AND H. V. ANDERSON, (*1*)D2309.
28 Qualitative Analysis, Elements of—, W. W. SCOTT, (*1*)Ja179.
29 Qualitative Analysis, Introductory—, J. CORNOG AND W. C. VOSBURGH, (*1*)Ja178.
30 *Qualitative Analysis—See* **A12**.
31 Qualitative Chemical Analysis, Introduction to—, D. P. SMITH AND H. K. MILLER, (*1*)Mr592.
32 *Qualitative Analysis—See* **A24**.
33 Qualitative Analysis, Solutions of Electrolytes, with Particular Application to—, L. P. HAMMETT, (*4*)D1303.
34 Quantitative Analysis, Analytical Chemistry, Vol. II, F. P. TREADWELL AND W. T. HALL, (*1*)Ja179, (*2*)2593.
35 Quantitative Analysis, The Fundamentals of—, 3rd ed., W. C. BLASDALE, (*1*) My1003.
36 Quantitative Analysis, The Theory and Technique of—, M. FARNSWORTH, (*1*) Mr588, (*2*)3173.
37 *Quantitative Calculations—See* **A4**.
38 *Ultra-Violet Light—See* **A10**.
39 *Vegetable Alkaloids—See* **A2**.
40 Volumetric Analysis. I. The Theoretical Principles of Volumetric Analysis, I. M. KOLTHOFF, H. MENZEL, AND N. H. FURMAN, (*1*)Mr594, (*2*)My1615.
41 Volumetric Analysis. II. Practical Volumetric Analysis, I. M. KOLTHOFF, H. MENZEL, AND N. H. FURMAN, (*1*)N2069.

B: Biological

1 Activity, Muscular—, A. V. HILL, (*3*)Mr477.
2 Amino Acids, The Biochemistry of the—, H. H. MITCHELL AND T. S. HAMILTON, (*4*)Je612.
3 Bacteria, Physiology and Biochemistry of—, Vol. I, R. E. BUCHANAN AND E. I. FULMER, (*3*)Mr467.
4 Bacteriology, Practical—, An Introduction to Bacteriological Technic, F. W. TANNER, (*4*)Ja94.
5 Biochemistry, Textbook of—, A. T. CAMERON, (*1*)Ja182.
6 *Biochemistry of the Amino Acids—See* **B2**.
7 *Biochemistry of Bacteria—See* **B3**.
8 Biologischen Arbeitsmethoden, Handbuch der— (Handbook of Biological Methods), Vol. I, Part II, Second Half, E. ABDERHALDEN, (*2*)D3685, (*3*)Ja160.
9 *Biology and Colloid Chemistry—See* **C11**.
10 Blood and Urine Chemistry, R. B. A. GRADWOHL AND I. E. GRADWOHL, (*1*)Ap818, (*4*)Ag801.
11 *Brewing Industry—See* **B20**.
12 Cell Phenomena, Mechanism of Enzyme Action and Associated—, F. F. NORD, (*1*)O1840.

13 Chemistry, Pharmaceutical and Medical—, 6th ed., S. P. SADTLER, J. HOSTMANN, AND F. P. STROUP, (*2*)Mr962.
14 Chemistry of Plant Products, An Introduction to—, 4th ed., Vol. I, P. HAAS AND T. G. HILL, (*4*)F194.
15 Chemistry of Plant Products, Metabolic Processes. An Introduction to the—, 2nd ed., Vol. II, P. HAAS AND T. G. HILL, (*1*)N2066, (*4*)N1150.
16 *Chemistry of Bacteria—See* **B3.**
17 Crime, The History of a—against the Food Law, H. W. WILEY, (*4*)N1149.
18 Diet, Wheat Flour and—, C. O. SWANSON, (*4*)F194.
19 Elektrizität and Eiweisse, insbesondere des Zellplasmas (Electricity and Proteins, with Especial Reference to Protoplasm), H. PFEIFFER, (*2*)S2846.
20 Enzymatische Technologie der Gärungsindustrien (Enzyme Technology of the Brewing Industry), A. HESSE, (*4*)S889.
21 *Enzyme Action and Cell Phenomena—See* **B12.**
22 Enzyme Action and Properties, E. WALDSCHMIDT-LEITZ AND R. P. WALTON, (*1*)Ap815, (*2*)Jy2282, (*3*)N1851, (*5*)F98.
23 *Food Law, The History of a Crime against the—See* **B17.**
24 Hormone and Innere Sekretion (Hormones and Internal Secretion), F. LAQUER, (*2*)Ja322.
25 *Medicine and Colloid Chemistry—See* **C11.**
26 *Metabolic Processes—See* **B15.**
27 *Muscular Activity—See* **B1.**
28 Pectic Substances of Plants, A Critical and Historical Study of the—, M. H BRANFOOT (M. H. CARRÉ), (*4*)D1303.
29 *Physiology of Bacteria—See* **B3.**
30 *Plant Products, Chemistry of—See* **B14** and **B15.**
31 *Plants, Pectic Substances of—See* **B28.**
32 *Proteins—See* **B19.**
33 *Protoplasm—See* **B19.**
34 Thyroxine, E. C. KENDALL, (*4*)Mr291.
35 *Urine Chemistry—See* **B10.**
36 *Wheat Flour and Diet—See* **B18.**

C: General, Inorganic, and Physical

1 Acids, Salts,—and Bases; Electrolytes; Stereochemistry, P. WALDEN AND L. F. AUDRIETH, (*1*)My1005, (*3*)D2021, (*5*)Je366.
2 *Adsorption—See* **C68.**
3 *Adsorption—See* **C69.**
4 Adsorption and Kapillarkondensation (Adsorption and Capillary Condensation), E. HÜCKEL, (*3*)F320.
5 Aluminates of Calcium, The Sulpho—, W. LERCH, F. W. ASHTON, AND R. H. BOGUE, (*1*)My1007.
6 Anisotropen Flüssigkeiten, Die—(Anisotropic Liquids), C. W. OSEEN, (*2*)O3174.
7 Anorganische Chemie, Gmelin's Handbuch der—(Gmelin's Textbook of Inorganic Chemistry), 8th ed., Eisen (Iron), R. J. MEYER, (*2*)D3679.
8 Do. Natrium (Sodium), R. J. MEYER, (*2*)Ap1296.
9 Do. Radium, O. ERBACHER, (*2*)Ap1297.
10 *Antimony—See* **C35.**
11 Applied Colloid Chemistry, Theoretical and—, Vol. II, Biology and Medicine, J. ALEXANDER, (*3*)Ag1273, (*4*)F194, (*5*)Mr167.
12 *Arsenic—See* **C35.**

13 Atlas der Letzten Linien der Wichtigsten Elemente (Atlas of the Persistent Lines of the Most Important Elements), F. LÖWE, (*2*)F641, (*4*)Ag801.
14 Atomic Structure as Modified by Oxidation and Reduction, W. C. REYNOLDS, (*2*) Mr958, (*3*)Ja159.
15 *Atomistics—See* C138.
16 Atomstruktur and Atombindung (Atomic Structure and Atomic Linkage), J. STARK, (*2*)F641, (*3*)Ap640.
17 Bandenspektra und ihre Bedeutung für die Chemie (Line Spectra and Their Significance in Chemistry), R. MECKE, (*3*)O1632, (*4*)Jy710.
18 *Bases—See* C1.
19 *Biology and Colloid Chemistry—See* C11.
20 *Bismuth—See* C35.
21 Brief Course in Chemistry, A—, L. C. NEWELL, (*1*)N2068.
22 *Calcium, The Sulphoaluminates of—See* C5.
23 *Calculations, Chemical—See* A3 and K5.
24 *Capillary Condensation—See* C4.
25 *Carbon Disulfide—See* C175.
26 Catalysis, A General Discussion on Homogeneous—Held by the Faraday Society, September, 1928, FARADAY SOCIETY, (*3*)Je959.
27 *Chemical Calculations—See* A3, K5, and C167.
28 Chemical Constitution, Crystal Structure and—. A General Discussion Held by the Faraday Society, March, 1929, FARADAY SOCIETY, (*3*)D2030.
29 *Chemical Analysis, Photometric—See* A20.
30 *Chemical Mass Action—See* C102.
31 Chemical Reactions and Their Equations, I. W. D. HACKH, (*1*)F402.
32 Chemie, Kurzes Lehrbuch der—in Natur und Wirtschaft. Band I. Allgemeine Chemie. Band II. Organische Chemie (A Short Treatise on Chemistry in Nature and Human Affairs. 2nd ed., Vol. I. General Chemistry. Vol. II. Organic Chemistry), C. OPPENHEIMER AND J. MATULA, (*2*)F640.
33 Chemistry, W. H. BARRETT, (*3*)Mr478.
34 *Chemistry, A Brief Course in—See* C21.
35 Chemistry, A Comprehensive Treatise on Inorganic and Theoretical—, Vol. IX, Arsenic, Antimony, Bismuth, Columbium, Tantalum and Vanadium, J. W. MELLOR, (*2*)My1614, (*3*)Jy1109, (*4*)My513, (*5*)My300.
36 Chemistry, A Textbook of Inorganic—, Vol. XI. Organometallic Compounds, Groups I to IV, K. N. FRIEND, A. E. GODDARD, AND D. GODDARD, (*5*)My300.
37 Chemistry, College—, N. E. GORDON, (*2*)Mr954.
38 Chemistry, Colloid—, 2nd ed.. THE SVEDBERG, (*1*)Ja183, (*2*)O3175, (*3*)Mr471.
39 *Chemistry, Colloid—See* C11.
40 Chemistry, Formulas and Symbols in—, R. M. CAVEN AND J. A. CRANSTON, (*2*)Ap 1297.
41 Chemistry, Fundamentals of—, C. W. GRAY, (*1*)My1002.
42 *Chemistry, General—See* C58 and C167.
43 Chemistry, General College—, J. A. BABOR, (*1*)D2308.
44 Chemistry, High-School—, W. M. MASTERS AND L. P. FLOYD, (*1*)F404.
45 *Chemistry in Nature—See* C32.
46 *Chemistry, Inorganic—See* C7 and C35.
47 Chemistry, Inorganic—for Colleges, W. FOSTER, (*1*)S1601.
48 Chemistry, Introductory Theoretical—, G. H. CARTLEDGE, (*1*)Ap814, (*2*)S2843.
49 *Chemistry, Laboratory Manuals in—See* C94 and C123–128.
50 *Chemistry, Mechano—See* C69.

51 *Chemistry, Physical—See* C160–165, and K5.
52 Chemistry, Reference Book of Inorganic—, W. M. LATIMER AND J. H. HILDEBRAND, (*1*)My1004.
53 Chemistry, Smith's College—, J. KENDALL, (*1*)N2068.
54 *Chemistry, Stereo—See* C1.
55 *Chemistry, Symbols in—See* C40.
56 Chemistry, Textbook of—for Nurses and Students of Home Economics, 2nd ed., A. T. MACLEOD, (*1*)Ja182.
57 *Chemistry, Theoretical—, See* C35, C48, and C160–165.
58 Chimie Générale Leçons sur la—(Lessons in General Chemistry), R. DUBRISAY, (*2*)Je1953.
59 Collected Works of J. Willard Gibbs, The—, 2 vols., W. R. LONGLEY AND R. GIBBS VAN NAME, (*1*)Mr591, (*2*)F639, (*3*)D2028.
60 *College, Inorganic Chemistry for—See* C47.
61 *College Chemistry—See* C37.
62 *College Chemistry, General—See* C43.
63 *College Chemistry, Smith's—See* C53.
64 *Colloid Chemistry—See* C11.
65 *Colloid Chemistry—See* C38.
66 *Colloidal Particles, Size of—See* C80.
67 Colloidal Salts, The—, H. B. WEISER, (*3*)Ja154, (*5*)Ag494.
68 Colloïdes, et l'Adsorption Données Numériques sur les—(Numerical Data on Colloids and Adsorption), R. AUDUBERT AND M. QUINTIN, (*4*)My513.
69 Colloid Mill, Mechanochemistry and the—Including the Practical Applications of Fine Dispersion, P. M. TRAVIS, (*3*)F317, (*5*)D745.
70 Colloid Symposium Monograph, Vol. VI, H. B. WEISER, (*1*)F405, (*3*)Ap633, (4)Ja 92 and S888.
71 *Colloids—See* C4.
72 *Columbium—See* C35.
73 Combustion, Lectures on—, J. PRIESTLEY AND J. MACLEAN, (*1*)D2310, (*2*)D3678.
74 *Condensation and Adsorption—See* C4.
75 Conduction of Electricity through Gases. Vol. I. General Properties of Ions, Ionization by Heat and Light. 3rd ed., J. J. THOMSON AND G. P. THOMSON; (*4*)My512.
76 *Corrosion—See* C121.
77 Corrosion of Metals, The— Part I. General Theory, W. PALMAER, (*2*)O3172.
78 *Crystal Structure—See* C28.
79 Data on Colloids, Numerical—*See* C68.
80 Determination of Hydrogen Ions, The—, 3rd ed., W. M. CLARK, (*2*)My1618, (*3*)Je 959, (*5*)F97.
81 Dispersoidanalyse. Die Methoden der Teilchengrössenbestimmung und Ihre Theoretischen Grundlagen (Analysis of Dispersoids. Methods for the Determination of the Size of Colloidal Particles and the Theoretical Considerations Involved), F. V. VON HAHN, (*2*)N3516.
82 *Electricity—See* C75 and C138.
83 *Electrolytes—See* C1.
84 *Electromotive Force—See* C86.
85 Elektrolyte, Über Lösungs- und Verdünnungswärmen einiger starker—(Heats of Solution and Dilution of Some Strong Electrolytes), E. LANGE, (*2*)F642.
86 Elektrolyten, Messungen Elektromotorischer Kräfte Galvanischer Ketten mit

Wässerigen—(Measurements of the Electromotive Forces of Galvanic Cells with Aqueous Electrolytes), 2nd vol. supp., C. DRUCKER, (*2*)Jy2280.

87 *Elements, Persistent Lines of—See* C13.

88 Elements, Radio—as Indicators, F. PANETH, (*3*)Mr474.

89 Emulsionen, Technik der—(Technical Treatment of Emulsions), O. LANGE, (*4*) Ag802.

90 Emulsions and Their Technical Treatment, The Theory of—, W. CLAYTON, (*2*) S2845.

91 *Energy—See* C138.

92 *Equations—See* C31.

93 *Equilibria—See* C59.

94 Experiments in General Chemistry, H. W. STONE AND M. S. DUNN, (*1*)O1838.

95 *Formulas in Chemistry—See* C40.

96 *Fundamentals of Chemistry—See* C41.

97 *Galvanic Cells—See* C86.

98 *Gases—See* C75.

99 *General Chemistry, Experiments in—See* C94.

100 *General Chemistry, Laboratory Manuals in—See* C123–126.

101 *General College Chemistry—See* C43.

102 Gesetz, Das—der Chemischen Massenwirkung. Seine Thermodynamische Begründung und Erweiterung (The Law of Chemical Mass Action. Its Thermodynamic Basis and Development), R. LORENZ, (*2*) Mr957.

103 *Gibbs—See* C59.

104 *Gmelin's Anorganische Chemie—See* C7–9.

105 *Heat—See* C75.

106 *Heat of Dilution—See* C85.

107 *Heat of Solution—See* C85.

108 *High-School Chemistry—See* C44.

109 *Home Economics, Chemistry for Students of—See* C57.

110 *Homogeneous Catalysis—See* C26.

111 Hydrogen-Ion Control, The A B C of—, 5th ed., W. A. TAYLOR, (*1*)Ap818.

112 *Hydrogen Ions, Determination of—See* C79.

113 Infra-Red Analysis of Molecular Structure, F. I. G. RAWLINS AND A. M. TAYLOR, (*4*) Ag801.

114 *Inorganic Chemistry—See* C7–9, C21, C32–37, C41–43, C47, C52–53, C58.

115 *Introductory Theoretical Chemistry—See* C48.

116 *Ion, Hydrogen—See* C79 and C111.

117 *Ionization—See* C75.

118 *Ions—See* C75.

119 *Iron—See* C7.

120 *Isotopes of Radium—See* C9.

121 Korrosion, Die—unter Berücksichtigung des Materialschutzes. I. Band. Allgemeiner und Theoretischer Teil (Corrosion, with a Consideration of the Protection of Materials. Vol. I. General and Theoretical Part), O. KRÖHNKE, E. MAASS, AND D. W. BECK, (*2*)D3681, (*4*)D1304.

122 *Laboratory Manual—See* C94.

123 Laboratory Manual Arranged to Accompany the Third Addition of "A Course in General Chemistry," WM. MCPHERSON, WM. E. HENDERSON, AND WM. L. EVANS, (*1*)Mr591.

124 Laboratory Manual in General College Chemistry, J. A. BABOR AND A. LEHRMANN, (*1*)D2309.

125 Laboratory Manual of General Chemistry, A—, L. B. RICHARDSON AND A. J. SCARLETT, JR., (*1*)Ja177.
126 Laboratory Outline of Smith's College Chemistry, J. KENDALL, (*1*)N2068.
127 Laboratory Manual of Elementary Physical Chemistry, A—, E. MACK, JR., AND W. G. FRANCE, (*3*) Jy1120.
128 *Laboratory Manual in Physical Chemistry—See* C164.
129 *Law of Mass Action—See* C102.
130 *Leçons sur la Chimie Générale—See* C58.
131 *Lectures on Combustion—See* C73.
132 *Light—See* C75.
133 *Lines of Most Important Elements, Persistent—See* C13.
134 *Liquids, Anisotropic—See* C6.
135 Liquids, The Viscosity of—, E. HATSCHEK, (*3*)Ap640.
136 *Mass Action—See* C102.
137 *Massenwirkung, Das Gesetz der Chemischen—See* C102.
138 Matter, Electricity, Energy. The Principles of Modern Atomistics and Experimental Results of Atomic Investigation, W. GERLACH AND F. J. FUCHS, (*2*)Je1953.
139 *Measurement and Weighing—See* C142.
140 *Mechanochemistry—See* C69.
141 *Medicine and Colloid Chemistry—See* C11.
142 Messen und Wägen, ein Lehr- und Handbuch insbesondere für Chemiker (Measurement and Weighing, a Text and Handbook, Especially for Chemists), W. BLOCK, (*2*)My1616.
143 *Metallic Compounds, Organo—See* C36.
144 *Metals, Properties of—See* A8.
145 *Metals, Corrosion of—See* C121.
146 Molecular Rearrangements, C. W. PORTER, (*1*)Ja181, (*2*)My1619, (*4*)F193.
147 *Molecular Structure—See* C113.
148 Molecular Weights in the Vapor State from Vapor Pressure and Evaporation Data, Determination of—, E. W. WASHBURN, (*1*)My1006.
149 Molecules, Polar—, P. DEBYE, (*2*) Jy2279.
150 *Monograph on Colloids—See* C71.
151 *Nature, Chemistry in—See* C32.
152 *Nephelometry—See* A20.
153 *Non-Metals, Properties of—See* A8.
154 *Nurses, Chemistry for—See* C57.
155 *Oxidation and Atomic Structure—See* C14.
156 *Phase Rule—See* C59.
157 Photochemische Versuchtechnik (Photochemical Technic), J. PLOTNIKOW, (*3*) O1630.
158 *Photometric Chemical Analysis—See* A20.
159 *Physical Chemistry—See* C48.
160 Physical Chemistry, Elementary—, F. S. TAYLOR, (*1*)Ja180.
161 Physical Chemistry, Elements of—, J. M. BELL AND P. M. GROSS, (*1*)S1599, (*2*)O3175.
162 Physical Chemistry, Theoretical and Experimental—, J. C. CROCKER AND F. MATTHEWS, (*3*)Jy1115.
163 Physikalische Chemie der Silikate (Physical Chemistry of the Silicates), W. EITEL, (*3*)Ag1277.
164 Physikalische-Chemische Praktikumsaufgaben (Experiments in Physical Chemistry), A. EUCKEN AND R. SUHRMANN, (*2*)Mr956, (*3*)My800.

165 Physikalischen Chemie, Lehrbuch der—(Textbook of Physical Chemistry), Vol. II, Parts II and III, K. JELLINEK, (*3*)Ap639.
166 *Polar Molecules—See* C149.
167 Problèmes et Calculs de Chimie Générale, Recueil Destiné aux Élèves des Grandes Écoles et aux Étudiants en Chimie (Problems and Calculations in General Chemistry, A Compilation for Students in Advanced Schools and Students of Chemistry), R. HOCART, (*2*)Ap1298.
168 *Radio Elements as Indicators—See* C88.
169 *Radium and Its Isotopes—See* C9.
170 *Reactions and Their Equations—See* C31.
171 *Reduction and Atomic Structure—See* C14.
172 *Reference Book of Inorganic Chemistry—See* C52.
173 *Salts—See* C1.
174 *Salts, The Colloidal—See* C65.
175 Schwefelkohlenstoff, Der—. Seine Eigenschaften, Herstellung und Verwendung (Carbon Disulfide, Its Properties, Preparation, and Uses), O. KAUSCH, (*4*)Ap392.
176 *Silicates—See* C163.
177 *Smith's College Chemistry—See* C53.
178 *Smith's College Chemistry, Laboratory Outline to—See* C126.
179 *Sodium—See* C8.
180 Solutions, The Foundation of the Theory of Dilute—, J. H. VAN'T HOFF AND S. ARRHENIUS, (*1*)S1602.
181 *Stereochemistry—See* C1.
182 *Sulfoaluminates of Calcium—See* C5.
183 *Spectra—See* C13 and C17.
184 *Symbols in Chemistry—See* C40.
185 *Tantalum—See* C35.
185 *Theoretical Chemistry—See* C48.
187 *Theoretical Colloid Chemistry—See* C11.
188 *Theory of Corrosion of Metals—See* C77.
189 *Theory of Dilute Solutions—See* C180.
190 *Theory of Emulsions—See* C90.
191 Thermodynamics, The Fundamentals of Chemical—. Part I. Elementary Theory and Applications, J. A. V. BUTLER, (*2*)Je1954.
192 *Valence—See* C16.
193 *Vanadium—See* C35.
194 *Versuchstechnik, Photochemische—See* C157.
195 *Viscosity of Liquids—See* C135.
196 *Wägen—See* C142.
197 *Weighing and Measurements—See* C142.
198 *Works of Gibbs—See* C59.

D: Engineering Chemistry and Chemical Engineering

1 Accounting and Cost Finding for the Chemical Industries, G. A. PROCHAZKA, JR., (*4*)Ap391, (*5*)Mr166.
2 *Accumulators, Alkaline—See* D5.
3 *Alcohol—See* D120.
4 *Alkali Industry, Progress in—See* D106.
5 Alkaline Accumulators, J. T. CRENNELL AND F. M. LEA, (*4*)Mr294.
6 *Allan's Commercial Organic Analysis—See* A2.
7 *Aluminum, Vessels from—See* D279.

8 *American Association's Yearbook for Textile Chemists and Colorists—See* **D**185.
9 American Chemical Industry, The—, DEPARTMENT OF COMMERCE, WASH., (*1*)Jy-Ag1373.
10 *American Chemistry, Survey of—See* **D**14.
11 American Soap Maker's Guide. An Up-to-Date Treatise on the Art and Science of the Manufacture of Soaps, Candles, and Allied Toilet Preparations, 3rd ed., I. V. S. STANISLAUS AND P. B. MEERBOTT, (*1*)Ap816, (*4*)Mr291, (*5*)Mr168.
12 *Annual Engineering Tables—See* **D**21.
13 Annual Reports of the Society of Chemical Industry on the Progress of Applied Chemistry. Vol. XIII, 1928, SOCIETY OF CHEMICAL INDUSTRY, LONDON, (*4*)S888
14 Annual Survey of American Chemistry, Vol. III, July 1, 1927–July 1, 1928, C. J. WEST, (*1*)F402, (*2*)Ap1296, (*3*)My798, (*4*)Ja92, (*5*)Mr168.
15 Anthracen und die Anthrachinone mit den Zugehörigen vielkernigen Systemen, Das—(Anthracene and Anthraquinones and Their Polynuclear Systems), J. HOUBEN AND W. FISCHER, (*2*)My1620, (*4*)Ja95.
16 *Anthraquinone—See* **D**15.
17 *Apparatus Construction—See* **D**286.
18 *Applied Catalytic Processes—See* **D**43.
19 *Applied Chemistry, Progress of—See* **D**13.
20 Arc Welding; Lincoln Price Papers, AMERICAN SOCIETY OF CHEMICAL ENGINEERS, (*5*)N690.
21 Art de L'Ingénieur et Métallurgie, Rèsistance des Materiaux et Données Numériques Diverses. Tables Annuelles de Constantes et Données Numériques, Extrait du Volume VI, 1923–1924 (The Engineer's Trade and Metallurgy, The Resistance of Substances and Various Numerical Data. Annual Tables of Constants and Numerical Data. Extracts from Volume VI, 1923–1924), L. DESCROIX, (*4*)Mr294.
22 *Artificial Liquids—See* **D**68.
23 *Artificial Resins—See* **D**148.
24 Artificial Silk, F. REINTHALER AND F. M. ROWE, (*4*)Jy 710,(*5*)O622.
25 *Aspects of Immunity—See* **D**47.
26 *Agriculture in Tropical Regions—See* **D**276.
27 *Balata—See* **D**41.
28 *Batteries, Storage—See* **D**249.
29 *Beryllium—See* **D**287.
30 Bestimmung der Dauerfestigkeit der Knetbaren, Veredelbaren Leichtmetallegierungen, Die—(The Determination of the Stability of the Soft, Refinable Alloys of Light Metals), R. WAGNER, (*4*)Ja95.
31 Betriebschemiker, Der— Ein Hilfsbuch für die Praxis des Chemischen Fabrikbetriebes, 4th ed., (The Industrial Chemist. A Manual for the Practice in a Chemical Factory), B. WARSER, (*4*)S889.
32 *Bituminous Coal—See* **D**210.
33 Blast Furnace Practice, Vol. I, General Principles, Raw Materials, F. CLEMENTS, (*5*)Ag495.
34 *Boiler Rooms, Waste in—See* **D**105.
35 *Brennstoffe (Fuels)—See* **D**147.
36 *Brewing Industry—See* **B**20.
37 *Calendar, Dyers'—See* **D**80.
38 *Candles—See* **D**11.
39 Caoutchouc, Le—. Étude Économique et Statistique (Economical and Statistical Studies of Rubber), J. C. DE MACEDO SOARES, (*4*)F195.
40 Caoutchouc, Les Industries du—. Production-Culture. Fabrication des Objects

en Caoutchouc. Travail de la Gomme Brute et Manufacture. Caoutchouc Artificiel et de Synthese (The Rubber Industry. Production and Culture. Production of Rubber Objects. Work on Crude Rubber and Its Manufacture. Artificial and Synthetic Rubber), H. DE GRAFFIGNY, (*4*)S889.

41 Caoutchouc, La Gomme de Balata. Un Volume de l'Encyclopédie du- et des Matières Plastiques. (Rubber. An Encyclopedia on Rubber and Plastic Substances), A. D. LUTTRINGER, (*4*)My514.

42 *Carbon, Industrial—See* D129.

43 Catalytic Processes in Applied Chemistry, T. P. HILDITCH, (*3*)Ag1279, (*4*)N1149, (*5*)O622.

44 *Celluloid—See* D197.

45 *Cellulose Industry—See* D169.

46 *Chemical Apparatus—See* D286.

47 Chemical Aspects of Immunity, The—, 2nd ed., H. G. WELLS, (*4*)O991.

48 Chemical Engineering Catalog, The—, CHEMICAL CATALOG CO., 13th ed., (*4*)Ja93; 14th ed., (*4*)D1302.

49 *Chemical Engineers, Transactions of the Institution of—See* D274.

50 *Chemical Industry, American—See* D9.

51 Chemical Patents Index, Vol. I, E. C. WORDEN, *First*, (*2*)Mr960.

52 *Chemical Technology—See* D142.

53 Chemie der Zuckerindustrie. Ein Handbuch für Wissenschaft und Praxis (Chemistry of the Sugar Industry. A Manual for Science and Practice), 2nd ed., O. WOHRYZEK, (*4*)Ja94.

54 Chemische Laboratorien. Ihre Neuzeitliche Einrichtung und Leitung (Chemical Laboratories. Their Modern Equipment and Guidance), A. BEHRE, (*4*)Ja95.

55 *Chemist, Industrial—See* D31.

56 *Chemist's Handbook, Gas—See* D111.

57 *Chemistry, Annual Survey of American—See* D14.

58 *Chemistry, Industrial—See* D85 and D132.

59 Chemistry of Leather Manufacture, The—, Vol. II, 2nd ed., J. A. WILSON, (*4*) D1302.

60 Chemistry of Pulp and Paper Making, The—, 2nd ed., E. SUTERMEISTER, (*4*)Jy710.

61 *Chemistry of Starch—See* D242.

62 *Chemistry of Sugar Industry—See* D53.

63 *Chromium Plating—See* D250.

64 *Coal—See* D147, D195, and D210; also F13.

65 *Colloidal State in Industry—See* D96.

66 *Colorists' Yearbook—See* D185.

67 *Color Matching—See* D98.

68 Combustibles Liquid Artificiels, Les Encyclopédie Léauté (Artificial Combustible Liquids. Léauté's Encyclopedia), A. MAILHE, (*4*)S888.

69 *Commercial Gases—See* D259.

70 *Conference on Bituminous Coal—See* D210.

71 *Congress on Photography—See* D211.

72 *Constants, Tables of—See* D21.

73 *Copper, Vessels from—See* D279.

74 *Cost Finding for the Chemical Industry—See* D1.

75 *Creep Strength of High Nickel-High Chromium Steels—See* D215.

76 *Crops, Tropical—See* D276.

77 Data on Industrial Heating Processes, 2nd ed., ENGINEERING DEPT., THE SURFACE COMBUSTION CO., (*4*)F194.

78 *Data, Table of Various Numerical—See* D21.
79 *Determination of Hydrogen Ions, The—See* C79.
80 Deutscher Färberkalender für das Jahr 1929, 38th ed. (German Dyers' Calendar for the Year 1929), DEUTSCHE FÄRBER ZEITUNG, (*4*)Ap393.
81 Diagramme und Tabellen zur Berechnung der Absorption—Kältemaschinen (Diagrams and Tables for Calculation with Regard to Absorption—Refrigerating Machine), F. R. MERKEL AND F. BOSNJAKOVIC, (*4*)Ag802.
82 *Dyeing—See* D204.
83 *Dyers' Calendar—See* D80.
84 *Economics, Industrial—See* D134.
85 Einführung in die Theoretische Wirtschafts-Chemie (Introduction to Theoretical Industrial Chemistry), R. KOETSCHAU, (*4*)N1151.
86 *Electrochemistry—See* D205.
87 Elementary Foundry Technology, L. A. HARTLEY, (*5*)F97.
88 *Emulsions—See* D197, C89, and C90.
89 *Engineer, The Sales—See* D227.
90 *Engineering Catalog, Chemical—See* D48.
91 *Engineering, Ice—See* D126.
92 *Engineering Tables—See* D21.
93 *Engineering Use of Probability—See* D208.
94 *Enzymatische Technologie der Gärungsindustrien* (*Enzyme Technology of the Brewing Industry*)—*See* B20.
95 *Equilibrium Data and Industrial Development of Searles Lake—See* D133.
96 État Colloidal et l'Industrie, L'—(The Colloidal State and Industry), W. KOPACZEWSKI, (*2*)Mr961.
97 *Ethereal Oils—See* D285.
98 Exact Color Matching and Specifying, L. B. DESBLEDS, (*4*)N1148.
99 *Explosives—See* D186.
100 *Extracts of Malt—See* D164.
101 *Färberkalender—See* D80.
102 Farm Products in Industry, G. M. ROMMEL, (*4*) Mr292,(*5*)My299.
103 *Fats—See* D277.
104 Fertilizers. The Source, Character, and Composition of Fertilizer Materials, and Suggestions as to Their Use, E. B. VOORHEES, (*6*)F137.
105 Finding and Stopping Waste in Modern Boiler Rooms, COCHRANE CORP., (*4*)Ja94.
106 Fortschritte in der Kali Industrie (Progress in the Alkali Industry), C. HERMANN, (*5*)Ag494.
107 *Foundry Laboratories—See* D158.
108 *Foundry Technology—See* D87.
109 *Fuels—See* D147, D222, and D289.
110 *Furnace Practice, Blast—See* D33.
111 Gas Chemist's Handbook, 3rd ed., A. F. KUNBERGER, (*4*)Je612, (*5*)Jy432.
112 *Gases, Commercial—See* D259.
113 *German Dyers' Calendar—See* D80.
114 *Glass—See* D197.
115 Glycerol and the Glycols. Production, Properties, and Analyses, J. W. LAWRIE, (*2*)Mr962, (*5*)Mr166.
116 *Glycols—See* D115.
117 Handbook of Refrigerating Engineering, W. R. WOOLRICH, (*4*)Mr293, (*5*)Ag494.
118 *Handbook, Gas Chemists'—See* D111.
119 *Handbook, Materials'—See* D172.

120 Handbuch der Spiritus Fabrikation (Handbook of the Manufacture of Alcohol), G. FOTH, (*4*)Jy711.
121 *Harz—See* **D**148.
122 *Heating, Industrial—See* **D**77.
123 Heat Insulators, E. GRIFFITHS, (*4*)D1304.
124 Heat Transmission, M. FISHENDEN AND A. F. DUFTON, (*4*)My512.
125 *Hydrogen Ions—See* **C**79 and **C**111.
126 Ice Engineering, H. T. BARNESS, (*3*)Je956.
127 *Immunity, Chemical Aspects of—See* **D**47.
128 Impurities in Metals, Their Influence on Structure and Properties, C. J. SMITHELLS, (*4*)Mr291,(*5*)Mr166.
129 Industrial Carbon, C. L. MANTELL, (*4*)Mr293, (*5*)My299.
130 *Industrial Chemist—See* **D**31.
131 *Industrial Chemistry—See* **D**85.
132 Industrial Chemistry, An Introduction, E. R. RIEGEL, (*5*)F99.
133 Industrial Development of Searles Lake Brines with Equilibrium Data, The—, J. E. TEEPLE, (*2*)Ag2594, (*4*)Jy709, (*5*)Jy430.
134 Industrial Economics, D. S. KIMBALL, (*5*)D744.
135 *Industrial Heating Processes—See* **D**77.
136 *Industry, Accounting and Cost Finding in the Chemical—See* **D**1.
137 *Industry, Colloidal State in—See* **D**96.
138 *Industry, Farm Products in—See* **D**102.
139 *Industry, Progress in the Alkali—See* **D**106.
140 *Industry, Silicates in—See* **D**236.
141 *Ingot Steel, Vessels from—See* **D**279.
142 Inorganic Chemical Technology, W. L. BADGER AND E. M. BAKER, (*1*)Mr595, (*4*)D1303, (*5*)My299.
143 *Institution of Chemical Engineers, Transactions of the—See* **D**274.
144 *Insulators, Heat—See* **D**123.
145 *Inventions—See* **D**267 and **D**268.
146 *Iron, Photomicrographs of—See* **D**199.
147 Kohlen, Von den- und den Mineralölen. Ein Jahrbuch für Chemie und Technik der Brennstoffe und Mineralöle. Band I—1928 (Coal and Mineral Oils. Year Book of the Chemistry and Technic of Fuels and Mineral Oils), VEREIN DEUTSCHER CHEMIKER, (*4*)Ag802.
148 Künstlichen Harze, Die— (Artificial Resins), J. SCHEIBER AND K. SÄNDIG, (*2*)D 3686, (*4*)Ag801, (*5*)N688.
149 Künstliche Organische Pigmentsfarben und Ihre Anwendungsgebiete (Artificial Organic Colors for Pigments and the Region of Their Application), C. A. CURTIS, (*4*)Jy710.
150 *Laboratories—See* **D**54 and **D**158.
151 *Laboratories in Foundries—See* **D**158.
152 Labor Management, G. S. WATKINS, (*4*)F194.
153 *Lacquer—See* **D**255.
154 *Lead Chamber Process—See* **D**209.
155 *Leather—See* **D**59.
156 Lehrbuch der Seifenfabrikation (Textbook of Soap Manufacture), J. DAVIDSOHN, (*2*)D3688.
157 *Leichtmetallegierungen—See* **D**30.
158 Leitfaden für Giessereilaboratorien (Manual for Foundry Laboratories), 3rd ed., B. OSMANN, (*4*)Ap392.

159 *Lincoln Price Papers on Arc Welding—See* D20.
160 *Liquids, Artificial—See* D68.
161 *List on Papermaking Materials—See* D219.
162 *Lubricants—See* D228.
163 *Malts, Extracts from—See* D164.
164 Malzextrakte, Die—(Extracts from Malt), J. WEICHHERZ, (*4*)Mr294.
165 *Management of Labor—See* D152.
166 Manufacture of Pulp and Paper, The—, Vol. IV, 2nd ed., J. N. STEPHENSON, (*5*)F97.
167 Do. Vol. V, 2nd ed., J. N. STEPHENSON, (*5*)Jy431.
168 *Manufacture of Soap—See* D156.
169 Massanalytische Verfahren und deren Anwendung in Zellstoffabriken; mit Anhang: Chemische Einwirkung der Schwefligen Säure auf Organische Stoffe in der Sulfitablauge (Application of Volumetric Methods in the Cellulose Industry. With Appendix: Chemical Action of Sulfurous Acid on Organic Materials in the Sulfite Liquor) E. OEMAN AND W. SCHMIDT, (*4*)My514.
170 *Matching Colors—See* D98.
171 *Materials for Paper Making—See* D219.
172 Materials Handbook, G. S. BRADY, (*5*)Je366.
173 *Materials, Raw—and Blast Furnace Practice—See* D33.
174 Meat through the Microscope—Applications of Chemistry and the Biological Sciences to Some Problems of Meat Packing Industry, C. R. MOULTON, (*4*)O992.
175 *Metallurgical Methods and Processes—See* D179.
176 *Metallurgy, Principles of—See* D206.
177 *Metals, Impurities in—See* D128.
178 *Metals, Stability of—See* D240.
179 Méthodes et Procédés Métallurgiques (Metallurgical Methods and Processes), M. REGNAULT, (*4*)My513.
180 *Methods of Testing Petroleum—See* D241.
181 Methods in Non-Ferrous Metallurgical Analysis, R. KEFFER, C. L. MCNEIL AND A. BUTTS, (*5*)F100.
182 *Mineral Oils—See* D147 and D289.
183 Mineral Raw Materials. Survey of Commerce and Sources in Major Industrial Countries, J. W. FURNESS, L. M. JONES, AND F. H. BLUMENTHAL, (*4*)S888, (*5*)Jy 431.
184 *Mining Tin—See* D272.
185 1928 Year Book of the American Association of Textile Chemists and Colorists, AM. ASSOC. OF TEXTILE CHEMISTS AND COLORISTS, (*4*)Je612.
186 Nitroglycerine and Nitroglycerine Explosives, P. NAOUM AND E. M. SYMMES, (*4*)Ja92.
187 *Nitrocellulose Lacquer—See* D255.
188 *Non-Ferrous Metallurgical Analysis—See* D181.
189 *Numerical Data, Tables of Various—See* D21.
190 *Oils—See* D147, D277, D285, and D289.
191 *Organic Pigments, Artificial—See* D149.
192 *Paper—See* D60, D166–167, D197, and D219.
193 *Patents Index—See* D51.
194 *Petroleum—See* D241.
195 Petroleum and Coal—The Keys to the Future, W. T. THOM, JR., (*4*)Ap391.
196 Petroleum Development and Technology, 1928–9, THE AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS, (*4*)N1149.

197 Photographic Emulsions. Their Preparation and Coating on Glass, Celluloid, and Paper, Experimentally and on the Large Scale, E. J. WALL, (*4*)N1150.
198 *Photography—See* D211.
199 Photomicrographs of Iron and Steel, E. L. REED, (*5*)F100.
200 *Pigments—See* D149.
201 *Plating with Chromium—See* D250.
202 *Polynuclear Systems of Anthracene and Anthraquinone—See* D15.
203 Practical Steel Making, W. LISTER, (*4*)O992.
204 Praktikum der Färberei und Druckerei (The Technic of Dyeing and Printing), K. BRASS, (*2*)D3687.
205 Principles and Application of Electrochemistry. Vol. I. Principles, 2nd ed., H. J. CREIGHTON, (*5*)D745.
206 Principles of Metallurgy, The—, J. L. BRAY, (*4*)S887, (*5*)Ag495.
207 *Printing—See* D204.
208 Probability and Its Engineering Uses, T. C. FRY, (*3*)O1632.
209 Procédés Modernes de Fabrication de l'Acide Sulfurique. Chambers de Plomb (Modern Methods of the Manufacture of Sulfuric Acid. Lead Chamber Process), L. PIERRON, (*4*)Jy710.
210 Proceedings of the Second International Conference on Bituminous Coal, November 19–24, 1928, 2 Vols., CARNEGIE INSTITUTE OF TECHNOLOGY, (*4*)Ag800, (*5*)Jy432.
211 Proceedings of the Seventh International Congress on Photography, W. CLARK, T. S. PRICE, AND B. V. STORE, (*2*)D3680.
212 *Processes, Catalytic—See* D43.
213 *Processes, Industrial Heating—See* D77.
214 *Progress in the Alkali Industry—See* D106.
215 Properties of Material at High Temperatures. 5. The "Creep" Strength of a "High Nickel-High Chromium Steel" between 600°C. and 800°C., H. J. TAPSELL AND J. REMFRY, (*4*)S887.
216 *Pulp—See* D60, D166–167.
217 *Raw Materials and Blast Furnace Practice—See* D33.
218 *Raw Materials, Mineral—See* D183.
219 Reading List on Papermaking Materials, 2nd ed., C. J. WEST, (*4*)F195, (*5*)F98.
220 *Refrigerating Engineering—See* D117 and E13.
221 *Refrigerating Machines, Tables for—See* D81.
222 Report of the Fuel Research Board for the Period Ended 31st March, 1928, DEPT. OF SCIENTIFIC AND INDUSTRIAL RESEARCH, LONDON, (*4*)Ja93.
223 *Reports on Progress of Applied Chemistry—See* D13.
224 *Resins—See* D148.
225 *Resistance of Substances—See* D21.
226 *Rubber—See* D39–41.
227 Sales Engineer, The—, G. RIGG, (*5*)Mr167.
228 Schmiermittel und Ihre Richtige Verwendung (Lubricants and Their Correct Use), C. EHLERS, (*4*)Ja95.
229 *Searles Lake—See* D133.
230 *Seifenfabrikation—See* D156.
231 *Siemens-Konzern, Publications of the—on Beryllium—See* D287.
232 *Silicates in Industry—See* D236.
233 *Silk, Artificial—See* D24.
234 *Soap—See* D11 and D156.
235 *Society of Chemical Industry, Reports of—on Progress of Applied Chemistry—See* D13.

236 Soluble Silicates in Industry, J. G. VAIL, (2)F644, (3)My795, (4)F193.
237 *Specifying Colors—See* D98.
238 *Spiritusfabrikation—See* D120.
239 *Stability of Alloys—See* D30.
240 Stability of Metals at Elevated Temperatures, The—, C. L. CLARK AND A. E. WHITE, (4)F193.
241 Standard Methods of Testing Petroleum and Its Products, THE INSTITUTION OF PETROLEUM TECHNOLOGISTS, GREAT BRITAIN, (4)O992.
242 Starch, Its Chemistry, Technology, and Uses, L. EYNON AND J. H. LANE, (5)N688.
243 *Steels, Creep Strength of Some—See* D215.
244 *Steel, Ingot—. Vessels Made from—See* D279.
245 *Steel Making—See* D203.
246 *Steel, Photomicrographs of—See* D199.
247 *Steel, Vessels Made from—See* D279.
248 *Stopping Waste in Boiler Rooms—See* D105.
249 Storage Batteries, M. ARENDT, (5)F99.
250 Study of Chromium Plating, A—, R. SCHNEIDEWIND, (4)F193, (5)F100.
251 *Sugar Industry—See* D53.
252 *Sulfite Liquor of the Cellulose Industry, Action of Sulfurous Acid on Organic Materials in the—See* D169.
253 *Sulfuric Acid—See* D209.
254 *Survey of American Chemistry—See* D14.
255 Survey of Nitrocellulose Lacquer, A—, B. K. BROWN AND M. CRAWFORD, (4)Ja93.
256 *Tables Concerning Refrigerating Machines—See* D81.
257 *Tables for the Engineer—See* D21.
258 *Technik der Emulsionen (Technic of Emulsions)—See* C89.
259 Technische Gase, ihre Herstellung und ihre Verwendung (The Preparation and Application of Industrial Gases), F. MUHLERT AND K. DREWS, (2)Jy2280.
260 *Technology, Elementary Foundry—See* D87.
261 *Technology, Inorganic Chemical—See* D142.
262 *Technology of Oils and Fats—See* D277.
263 *Technology of Petroleum—See* D196.
264 *Technology of Starch—See* D242.
265 *Technology of the Brewing Industry—See* D94.
266 *Technology of Tin—See* D272.
267 Textilchemische Erfindungen. Lieferung. II. 1. July–Dezember 1927. Lieferung III. 1. Januar—30. Juni 1928 (Textile Chemical Inventions. Part II—July 1–December 1, 1927. Part III—January 1–June 30, 1928), A. LEHNE, (4) My514.
268 Do. Lieferung IV—1. July 1–Dezember 1928 (Vol. IV. July 1–December 1, 1928), A. LEHNE, (4)S889.
269 *Textile Chemist's Yearbook—See* D185.
270 Theoretical Industrial Chemistry—*See* D85.
271 *Theory of Emulsions and Their Technical Treatment, The—See* C90.
272 Tin. Its Mining, Production, Technology, and Application, C. L. MANTELL, (4) D1303.
273 *Toilet Preparations—See* D11.
274 Transactions of the Institution of Chemical Engineers, Vol. 5—1927, INSTITUTION OF CHEMICAL ENGINEERS, (4)Ap392.
275 *Transmission of Heat—See* D124.
276 Tropical Crops, The—. A Popular Treatment of the Practice of Agriculture in

Tropical Regions, with Discussion of Cropping Systems and Methods of Growing the Leading Products, O. W. BARRETT, (*4*)Mr293.

277 Ubbelohde's Handbuch der Chemie und Technologie der Öle und Fette. Band I (Ubbelohde's Handbook of the Chemistry and Technology of Oils and Fats. Vol. I), 2nd ed., H. HELLER, (*4*)Jy711.

278 *Walls of Vessels Subjected to Pressure, Thickness of—See* **D**279.

279 Wandstärkenberechung Druckbeanspruchter Gefässe aus Schweisstahl—, Flusstahl—, Kupfer—, und Aluminiumblech im Apparatenbau, Die—(Calculation for the Thickness of the Walls of Those Vessels Which Are Subjected to Pressure and Made from Weld Steel, Ingot Steel, Sheet Copper, and Sheet Aluminum), H. MELHARDT, (*4*)Ag802.

280 Wasser, Vom—. Ein Jahrbuch für Wasserchemie und Wassereinigungstechnik. Band II (On Water. Year Book on Water Chemistry and the Technic of Water Purification), VEREIN DEUTSCHE CHEMIKER, (*4*)Ap393.

281 *Waste in Boiler Rooms—See* **D**105.

282 *Water—See* **D**280.

283 *Welding, Arc—See* **D**20.

284 *Weld Steel, Vessels from—See* **D**279.

285 Weltproduktion und Welthandel von Ätherischen Ölen und die Wirtschaftliche Entwicklung Ihrer Industrie (World Production and World Commerce of Ethereal Oils and the Commercial Development of Their Industry), H. H. ZANDER, (*4*)Ap393.

286 Werkstoffe für den Bau Chemischer Apparate, Die—(The Materials for the Construction of Chemical Apparatus), A. FÜRTH, (*4*)Ap392, (*5*)Mr168.

287 Wissenschaftliche Veröffentlichungen aus dem Siemens-Konzern. VIII Band, I Heft. Beryllium-Arbeiten(Scientific Publications of the Siemens Konzern. Vol. VIII, No. I. Work on Beryllium), SIEMENS UND HALSKE, A.-G., (*4*)S889.

288 *Yearbook for Textile Chemists and Colorists—See* **D**185.

289 *Yearbook on Fuels and Mineral Oils—See* **D**147.

290 *Year Book on the Chemistry of Water—See* **D**280.

291 *Zuckerindustrie—See* **D**53.

E: Historical

1 Alchemy, The Ordinall of, T. NORTON OF BRISTOLL, (*1*) My1001.

2 *Chemical Science. Origin and Growth of—See* **E**25.

3 Chemistry, History of Recent—, R. NAKASEKO, (*1*)Je1182.

4 Chemistry, Universal History of Sekai Kwagaku-shi, R. NAKASEKO, (*1*)Ja184.

5 *Chemists of Our Time, Eminent—See* **E**11.

6 *Collected Works of J. Willard Gibbs—See* **C**59.

7 *Combustion, Lectures on—See* **C**73.

8 *Dilute Solutions, The Foundations of the Theory of—See* **C**180.

9 Discovery of the Rare Gases, The—, M. W. TRAVERS, (*3*)Ja159, (*4*)My513, (*5*) Jy430.

10 *Dynamite and Peace, Nobel—See* **E**23.

11 Eminent Chemists of Our Time, 2nd ed., B. HARROW, (*3*)Mr479.

12 *Foundations of the Theory of Dilute Solutions, The—See* **C**180.

13 50 Jahre Kältetechnik (Fifty Years of Refrigerating Technic), GESELLSCHAFT FÜR LINDE'S EISMASCHINEN A.-G., (*4*)N1151.

14 *Gases, The Discovery of the Rare—See* **E**9.

15 *Geber, The Works of—See* **E**34.

16 *Gibbs, The Works of—See* **C**59.

17 *Growth of Chemical Science—See* **E**25.

18 Higgin's Book "A Comparative View of the Phlogistic and Antiphlogistic Doctrines," Report on—, HIGGIN, (*1*)S1604.
19 *History of Recent Chemistry—See* **E**3.
20 *History of Universal Chemistry—See* **E**4.
21 John Wesley among the Scientists, F. W. COLLIER, (*1*)Jy-Ag1371.
22 *Lectures on Combustion—See* **C**73.
23 Nobel—Dynamite and Peace, R. SOHLMAN, H. SCHÜCK, BRIAN AND BEATRIX LUNN. (*4*)Je611, (*5*)Je365.
24 *Ordinall of Alchemy, The—See* **E**1.
25 Origin and the Growth of Chemical Science, The—, J. E. MARSH, (*2*)My1613.
26 *Phlogiston Theory—See* **E**18 and **C**73.
27 *Peace, Nobel, Dynamite and—See* **E**23.
28 *Rare Gases, Discovery of—See* **E**9.
29 *Refrigerating Technic—See* **E**13.
30 *Sekai Kwagaku-Shi—See* **E**4.
31 *Theory of Dilute Solutions, The Foundations of the—See* **C**180.
32 *Wesley among the Scientists, John—See* **E**21.
33 *Works of J. Willard Gibbs—See* **C**59.
34 Works of Geber, The—, new ed., R. RUSSELL AND E. V. HOLMYARD, (*4*)Ap391.

F: Organic

1 *Abhandlungen—See* **F**12.
2 *Abhandlungen zur Kenntnis der Kohle—See* **F**13.
3 *Aldehydes—See* **F**37.
4 *Coal—See* **F**13 and **D**147, **D**195, and **D**210.
5 *Carbon Compounds, Pyrolysis of—See* **F**34.
6 Concise Summary of Elementary Organic Chemistry, A—, F. H. CONSTABLE, (*1*) N2066.
7 Constitution of the Sugars, The—, W. N. HAWORTH, (*4*)Jy709.
8 Elementary Organic Chemistry, H. ADKINS AND S. M. MCELVAIN, (*2*)F645.
9 *Elementary Organic Chemistry, A Concise Summary of—See* **F**6.
10 *Experiments in Organic Chemistry—See* **F**17.
11 *Food Chemistry, Organic and—See* **F**24.
12 Gesammelte Abhandlungen (Assembled Scientific Papers), Vol. V, F. KEHRMANN, (*2*)F644.
13 Gesammelte Abhandlungen zur Kenntnis der Kohle (Assembled Scientific Papers on Coal), F. FISCHER, (*2*)S2844.
14 Introduction to Modern Organic Chemistry, An—, L. A. COLES, (*3*)O1631.
15 *Introductory Organic Chemistry—See* **F**25.
16 Jahrbuch der Organischen Chemie (Yearbook of Organic Chemistry), J. SCHMIDT, (*2*)S2845.
17 Laboratory Experiments in Organic Chemistry, R. ADAMS AND J. R. JOHNSON, (*5*)F98.
18 *Laboratory Methods, Organic—See* **F**29.
19 *Medicine, Organic Chemistry for Students of—See* **F**27.
20 *Methods, Organic Laboratory—See* **F**29.
21 *Modern Organic Chemistry—See* **F**14.
22 *Molecular Rearrangements—See* **C**146.
23 Organische Chemie (Organic Chemistry), 2nd ed., C. OPPENHEIMER, (*2*)Ja320.
24 Organic and Food Chemistry, G. E. CULVER AND T. A. ROGERS, (*1*)D2310.
25 Organic Chemistry. A Brief Introductory Course, J. B. CONANT, (*2*)My1619.

26 *Organic Chemistry—See* C32.
27 Organic Chemistry for Students of Pharmacy and Medicine, A. H. CLARK, (*1*) O1838.
28 *Organic Chemistry, Yearbook on—See* F16.
29 Organic Laboratory Methods, LASSAR-COHN, R. E. OESPER, R. ADAMS, AND H. T. CLARKE, (*1*)Mr594, (*2*)S2844, (*4*)Ap392.
30 Organic Synthesis. An Annual Publication of Satisfactory Methods for the Preparation of Organic Chemicals, Vol. IX, J. B. CONANT, (*1*)My1002, (*2*)Je1958, (*4*)My513.
31 *Organo-Metallic Compounds—See* C36.
32 *Perfumes—See* F37.
33 *Pharmacy, Organic Chemistry for Students of—See* F27.
34 Pyrolysis of Carbon Compounds, The—, C. D. HURD, (*2*)Ag2596, (*3*)Jy1112, (*4*)Ag800, (*5*)Jy431.
35 *Rearrangements, Molecular—See* C146.
36 Richter-Anschütz Chemie der Kohlenstoffverbindungen oder Organische Chemie (Chemistry of the Compounds of Carbon or Organic Chemistry), Vol. 1. Aliphatic Compounds, R. ANSCHÜTZ AND F. REINDEL, (*2*)Je1957.
37 Riechstoffe und ihre Derivate. Aldehyde. Erste Abteilung: Aldehyde der aliphatischen Reihe, Die— (Perfumes and Their Derivates. Aldehydes. First Part: Aldehydes of the Aliphatic Series), A. WAGNER, (*4*)N1151.
38 *Sugars, Constitution of—See* F7.
39 *Synthesis, Organic—See* F30.
40 Textbook of Organic Chemistry, A—, 2nd ed., J. S. CHAMBERLAIN, (*1*)Ap817, (*2*)Jy2281.
41 *Year Book of Organic Chemistry—See* F16.

G: Popular

1 At Home among the Atoms, J. KENDALL, (*1*)N2065.
2 *Atoms—See* G1.
3 Buch der Grossen Chemiker, Das— (The Book of the Great Chemists. From Zosimos to Schönbein), Vol. I, G. BUGGE, (*2*)O3172, (*4*)N1150, (*5*)N689.
4 *Chemists of Our Time—See* E11.
5 Chemical Warfare, The Medical Aspects of—, E. B. VEDDER AND D. C. WALTON, (*1*)Jy-Ag1370.
6 Chemistry in Daily Life, S. GLASSTONE, (*1*)D2308.
7 Chemistry in Medicine, J. STIEGLITZ, (*1*)Mr590, (*4*)F195.
8 Chimie, La Grand Oeuvre de la— (The Great Work of Chemistry), CHIMIE ET INDUSTRIE, PARIS, (*4*)D1304, (*5*)N689.
9 Forty Years with General Electric, J. T. BRODERICK, (*5*)N690.
10 Handwriting on the Wall, The—. A Chemist's Interpretation, A. D. LITTLE, (*1*)F405, (*4*)Mr2291.
11 Industrial Explorers. Word Portraits of Industrial Research Leaders, M. HOLLAND AND H. F. PRINGLE, (*4*)F195.
12 *Life, Chemistry in Daily—See* G6.
13 *Medical Aspects of Chemical Warfare—See* G5.
14 *Medicine, Chemistry in—See* G7.
15 Moderne Methoden der Kohleverwertung (Modern Methods of Utilizing Coal), H. GROSSMANN, (*1*)Je1182.
16 Popular Research Narratives. Tales of Discovery, Invention, and Research. Vol. III, THE ENGINEERING FOUNDATION, (*4*)N1150, (*5*)N689.

17 Popular Science Talks, 1927–28, I. GRIFFITH, (*1*)Ap819.
18 Science for the Home Manager, MELLON INSTITUTE OF INDUSTRIAL RESEARCH. (*1*)Je1183.
19 *Warfare, The Medical Aspects of Chemical—See* G5.
20 Water Supply, The Story of—, H. HOLWAY, (*4*)N1150.

H: Bibliographical

1 Chemistry and Chemical Technology, Bibliography of Bibliographies on—. First Supplement, 1924–28, C. J. WEST AND D. D. BEROLZHEIMER, (*1*)O1840.
2 Education, 1926–27, Bibliography of Research Studies in—. Dept. of the Interior, No. 22, J. D. WOLCOTT, (*1*)Mr596.
3 Educational Publications, Record of Current—. Dept. of the Interior, No. 22, J. D. WOLCOTT, (*1*)My1107.
4 Examinations and School Marks, A Selected Annotated Bibliography Dealing with—. Bureau of Educational Research. No. 43, C. W. ODELL, (*1*)Mr595.
5 Industrial Research, Bibliographic Series of Mellon Institute of—. Second Supplement to No. 2, L. HEATON, (*1*)Je1183.
6 *Marks and Examinations—See* H4.
7 *Mellon Institute of Industrial Research—See* H5.
8 Metallic Corrosion, A Bibliography of—, W. H. J. VERNON, (*5*)Je366.
9 Pulp and Paper Making, Bibliography of—, 1900–28, C. J. WEST, (*4*)Ap391, (*5*) Ag494.
10 *Research, Bibliographic Series of Mellon Institute of Industrial—See* H5.
11 *Research Studies in Education—See* H2.
12 *Technology, Bibliography of Bibliographies on Chemical—See* H1.

I: Educational

1 Abstracts of Scientific and Technical Publications from the Massachusetts Institute of Technology. No. 3, THE TECHNOLOGY PRESS, (*1*)Je1184.
2 Accredited Secondary Schools in the United States. Bureau of Education, Bulletin No. 26, F. M. PHILLIPS, (*1*)Jy-Ag1374.
3 Achievement Relative to Capacity, A Critical Study of Measure of—, Bureau of Educational Research, No. 45, C. W. ODELL, (*1*)My1007.
4 Annual Report of the Commissioner of Education for Year Ended June 30, 1928. Dept. of the Interior, J. J. TIGERT, (*1*)Mr596.
5 Cases in the Administration of Guidance, J. M. BREWER, (*1*)O1839.
6 Chemical Engineering, 1903–28, Department of Chemistry and—, UNIVERSITY OF WASHINGTON, (*1*)Mr596.
7 *Chemistry and Chemical Engineering—See* I6.
8 Chemistry and Physics, INCORPORATED ASSOCIATION OF HEAD MASTERS OF PUBLIC SCHOOLS AND THE MINISTRY OF LABOR, (*1*)S1603.
9 Choice of an Occupation, The—, YALE UNIVERSITY, (*5*)Jy432.
10 College Students, Self-Help for—, Dept. of the Interior, No. 2, W. J. GREENLEAF, (*1*)Jy-Ag1374.
11 Costs in City Schools, Per Capita—1927–28, Dept. of the Interior, No. 12, F. M. PHILLIPS, (*1*)S1604.
12 Courses, Private and Endowed Schools Offering Trade and Industrial—, Dept. of the Interior, No. 18, M. M. PROFFITT, (*1*)Mr596.
13 Critical Study of Measure of Achievement Relative to Capacity, A—, C. W. ODELL, (*1*)My1007.
14 *Department of Chemistry and Chemical Engineering—See* I6.

15 *Education, Annual Report—See* I4.
16 Education, Laws Relating to Compulsory—, Dept. of the Interior, No. 20, W. W. KEESECHER, (*1*)Ap819.
17 Education, Publications of the U. S. Bureau of—of Special Interest to High-School Teachers, DEPT. OF THE INTERIOR, (*1*)Jy-Ag1374.
18 Education, Radio in—, A. PERRY, (*1*)O1840.
19 Education, Third Report of Commission on Medical—, A. L. LOWELL, (*1*)My1007.
20 Education in Other Countries, Major Trends of—, Dept. of the Interior, No. 13, J. F. ABEL, (*1*)Mr596.
21 Education of the Negro Race, Statistics of—, 1925–26, Dept. of the Interior, No. 19, D. T. BLOSE, (*1*)Ap819.
22 Educational Boards and Foundations, 1926–28, Bureau of Education, Bulletin No. 9, H. R. EVANS, (*1*)S1604.
23 Enriched Teaching of Science in the High School, M. N. WOODRING, M. E. OAKES, AND H. E. BROWN, (*1*)Je1181.
24 Fellowships and Scholarships for Advanced Work in Science and Technology, National Research Council, No. 72, 2nd ed., C. HULL AND C. J. WEST, (*1*)D2311.
25 Funds Available in the United States for the Support and Encouragement of Research in Science and Its Technologies, National Research Council, No. 66, 2nd ed., C. HULL AND C. J. WEST, (*1*)Ap819.
26 General Science for Reviews, W. D. PULVERMACHER AND C. H. VOSBURGH, (*1*)S1599.
27 *High School, Enriched Teaching of Science in the—See* 123.
28 High-School Graduation, Requirements for—, Dept. of the Interior, No. 21, C. A. JESSEN, (*1*)Mr596.
29 *High-School Teachers, Publications of Interest to—See* I17.
30 Higher Education, Biennial Survey, 1926–28, Bureau of Education, Bulletin No. 11, A. J. KLEIN, (*1*)S1604.
31 Illiteracy in the Various Countries of the World. Bureau of Education, Bulletin No. 4, J. C. ABEL AND N. G. BOND, (*1*)S1604.
32 Incentives to Study; A Survey of Student Opinion, A. B. CRAWFORD, (*1*)Jy-Ag 1371.
33 *Industrial Courses—See* I12.
34 Land-Grant Colleges and Universities for Year Ended June 30, 1927, Dept. of the Interior, No. 14, W. J. GREENLEAF, (*1*)Mr596.
35 *Laws Relating to Compulsory Education—See* I16.
36 *Major Trends of Education in Other Countries—See* I2.).
37 *Marks and Examinations—See* H4.
38 *Massachusetts Institute of Technology—See* I1.
39 *Measure of Achievement Relative to Capacity—See* I3.
40 Medical Education, 1926–28, N. P. COLWELL, (*1*)N2067.
41 *Medical Education, Third Report—See* I19.
42 Nature and Meaning of Teaching, The—, R. F. STREBEL AND G. C. MOREHART, (*1*)Je1181.
43 *Negro Race, Education of the—See* I21.
44 *Per Capita Costs in City Schools—See* I11.
45 Per Capita Costs in Teacher Training Institutions, 1927–28, F. M. PHILLIPS, (*1*)Jy-Ag1374.
46 *Physics, Chemistry and—See* I8.
47 *Private and Endowed Schools—See* I12.
48 Publications, Record of Current Educational—, Dept. of the Interior, No. 23, J. D. WOLCOTT, (*1*)My1007.

49 *Publications from the Massachusetts Institute of Technology—See* I1.
50 *Publications of Interest to High-School Teachers—See* I17.
51 Pupils Answers to Thought Questions, The Use of Scales for Rating—, C. W. ODELL, (*1*)Je1183.
52 *Radio in Education—See* I18.
53 *Rating Pupils' Answers to Thought Questions—See* I50.
54 *Record of Educational Publications—See* I47.
55 *Requirements for High-School Graduation—See* I28.
56 *Research, Funds for—See* I25.
57 *Research in Education—See* H2.
58 *Scales for Rating Pupils' Answers to Thought Questions—See* I51.
59 *Scholarships for Work in Science and Technology—See* I24.
60 School Betterment Studies, Vol. I, No. 2, Youth and the Good, H. C. FRICK, (*1*) Ap819.
61 School Betterment Studies, Vol. I, No. 3, Youth and the True, H. C. FRICK, (*1*) Jy-Ag1374.
62 *Schools, Accredited—See* I2.
63 *Schools, Per Capita Costs in—See* I44.
64 Schools of the Southern Association, Secondary—, J. ROEMER, (*1*)Ap819.
65 *Science in High School, Enriched—See* I23.
66 *Secondary Schools—See* I2 and I64.
67 *Self-Help for College Students—See* I10.
68 *Statistics of the Education of the Negro Race—See* I21.
69 *Students, Self-Help for College—See* I10.
70 *Study, Incentives to—See* I32.
71 *Teacher Training Institutions—See* I45.
72 *Teachers, Publications of Interest to—See* I17.
73 *Teaching, the Nature of—See* I42.
74 *Teaching, Enriched—See* I23.
75 *Third Report on Medical Education—See* I19.
76 *Trade and Industrial Courses—See* I12.
77 Unterrichtsprobleme in Chemie und Chemischer Technologie in Hinblick auf die Anforderungen der Industrie (Problems in the Education in Chemistry and Chemical Technology with a Consideration of the Requirements of Industry), W. J. MÜLLER, (*4*)Jy711.
78 *Use of Scales for Rating Pupil's Answers—See* I51.
79 *Vocational Guidance—See* I5.
80 *Youth and the Good—See* I60.
81 *Youth and the True—See* I61.

J: Physics

1 Crystals, The Physics of—, L. B. LOEB AND A. F. JOFFE, (*2*)Ja318, (*3*)Ja156.
2 Electrical Theory of Matter, Molecular Physics and—, J. A. CROWTHER, (*3*)D2025.
3 Electricity, Magnetism and—, M. MEISTER, (*1*)N2070.
4 Heat and Thermodynamics, J. K. ROBERTS, (*3*)My799.
5 Matter, The General Properties of—, F. H. NEWMAN AND V. H. L. SEARLE, (*3*) O1628.
6 Mechanics, Statistical—. The Theory of the Properties of Matter in Equilibrium, R. H. FOWLER, (*2*)D3682.
7 Modern Physics, Introduction to—, F. K. RICHTMEYER, (*1*)F403, (*2*)Je1955, (*3*) O1624.
8 *Magnetism—See* J3.

9 *Molecular Physics—See* J2.
10 Müller-Pouillets Lehrbuch der Physik. Lehre von der strahlenden Energie (Müller-Pouillets Textbook of Physics. The Theory of Radiant Energy), Vol. II, 11th ed., K. W. MEISSNER, (*2*)D3679.
11 Photoelectric Phenomena, B. GUDDEN, (*3*)O1631.
12 *Physics—See* J7.
13 *Physics of Crystals—See* J1.
14 Polarization Dielectrique (Dielectric Polarization), J. ERRERA, (*3*)Ag1279.
15 Spectroscopy of the Extreme Ultra-Violet, The—, 2nd ed., T. LYMAN, (*3*)Mr480.
16 *Statistical Mechanics—See* J6.
17 *Thermodynamics—See* J4.

K: Miscellaneous Texts

1 *Annual Survey of American Chemistry—See* D14.
2 Anorganische und Organische Entfärbungsmittel (Inorganic and Organic Decolorizing Agents), L. SINGER, (*2*)Ag2595, (*5*)Jy432.
3 Art of Rapid Thinking, The—, W. B. PITKIN, (*5*)D746.
4 Blue Book of Southern Progress, MANUFACTURER'S RECORD, (*1*)Jy-Ag1373.
5 Calculations in Physical Chemistry, J. R. PARINGTON AND S. K. TWEEDY, (*3*)Ja160.
6 *Chemical Calculations—See* A3.
7 *Chemical Dictionary—See* K22–24.
8 *Chemical Engineering Catalog—See* D48.
9 *Chemical Literature—See* K32.
10 Chemical Publications. Their Nature and Use, M. G. MELLON, (*1*)My1004, (*2*) Mr959, (*4*)Ja94, (*5*)F99.
11 Chemiker Kalender 1929. I—Taschenbuch. II—Dichten, Löslichkeiten, Analyse III—Theoretischer Teil (Chemist's Calendar 1929; Part I—Handbook. Part II—Densities, Solubilities, Analyses. Part III—Theoretical Part), R. BIEDERMANN, W. A. ROTH, AND I. KOPPEL, (*4*)Ap393.
12 Chemisches Nomogramme. Erste Sammlung. No. .001—.006 (Chemical Nomograms. First Collections. No. .001—.006), O. LIESCHE, (*4*) Ag802, (*5*)My300.
13 Chemische Fachwörterbuch für Wissenschaft, Technology, Industrie und Handel. Band I—Deutsch-Englisch-Französisch (Chemical Technical Dictionary for Science, Technic, Industry, and Commerce. Vol. I—German-English-French), A. W. MAYER, (*2*)My1614, (*4*)Je612, (*5*)My300.
14 Chemist's Pocket Manual, The—, 14th ed., R. K. MEADE, (*4*)D1303.
15 *Chemistry, Survey of American—See* D14.
16 Collection of Czechoslovak Chemical Communications, E. VOTOČEK AND J. HEYVOVSKÝ, (*2*)Je1953.
17 *Engineering Catalog, Chemical—See* D48.
18 Critical Tables of Numerical Data, Physics, Chemistry, and Technology, International—. Vol. V, E. W. WASHBURN, (*4*)My512.
19 Do. Vol. VI, E. W. WASHBURN, (*4*)D1304.
20 *Decolorizing Agents—See* K2.
21 Deutschen Chemischen Gesellschaft, Probleme der—(Problems of the German Chemical Society), P. WALLER, (*5*)N689.
22 Dictionary, A Chemical—, I. W. D. HACKH, (*5*)D744.
23 Dictionary of Chemistry and Mineralogy, An Etymological—, D. BAILEY AND K. C. BAILEY, (*4*)Je611.
24 Dizionario di Merceologia e di Chimica Applicata (Dictionary of Materials and Applied Chemistry), G. V. VILLAVECCHIA, (*4*)Ap393.

25 English and Science, P. M. McDONALD, (*3*)N1855, (*5*)D745.
26 *Entfärbungsmittel—See* K2.
27 Enzyclopädie der Technischen Chemie. Band I—Abasin—Ausdehnung. Band II—Auslaugapparate—Calcium Carbid (Encyclopedia of Industrial Chemistry. Vol. I and Vol. II), 2nd ed., F. ULLMANN, (*4*)Ap393.
28 Do. Vol. III, Calcium Cyanamid—Druckerei, 2nd ed., F. ULLMANN, (*4*)S889.
29 *General Science for Reviews—See* I26.
30 Geologie und Radioaktivität (Geology and Radioactivity), G. KIRSCH, (*3*)Jy1119.
31 *German Chemical Society—See* K21.
32 Guide to the Literature of Chemistry, A—, E. J. CRANE AND A. M. PATTERSON, (*2*)Je1956, (*3*)F319.
33 Handbook of Chemistry and Physics, 13th ed., C. D. HODGMAN AND N. A. LANGE, (*4*)Mr292, (*5*)Mr168.
34 *Home Economics, Chemistry for Students of—See* C57.
35 *Inorganic Chemical Technology—See* D142.
36 *International Critical Tables—See* K18–19.
37 Kraemer's Scientific and Applied Pharmacognosy, 3rd ed., E. L. NEWCOMB, (*2*) D3688.
38 *Literature of Chemistry—See* K10 and K32.
39 *Medical Education, Report on—See* I19.
40 *Mineralogy, Dictionary of—See* K23.
41 *Nurses, Chemistry for—See* C57.
42 *Pharmacognosy—See* K37.
43 *Physical Chemistry, Calculations in—See* K5.
44 *Pocket Manual, The Chemist's—See* K14.
45 *Probleme der Deutschen Chemischen Gesellschaft—See* K21.
46 *Publications, Chemical—See* K10.
47 *Radioactivity—See* K30.
48 *Rapid Reading—See* K3.
49 Recent Economic Changes in the United States, COMMITTEE ON RECENT ECONOMIC CHANGES OF THE PRESIDENT'S UNEMPLOYMENT CONFERENCE, (*5*)Je365.
50 *Science for Reviews—See* I26.
51 *Science, English and—See* K25.
52 *Southern Progress—See* K4.
53 *Survey of American Chemistry—See* D14.
54 *Technology, Inorganic Chemical—See* D142.
55 *Third Report on Medical Education—See* I19.

AUTHOR INDEX

(*References are to sections of the index, not to pages*)

ABDERHALDEN, E., B8.
ABEL, J. C., I31.
ABEL, J. F., I20.
ADAMS, R., F17, F29.
ADKINS, H., F8.
ALEXANDER, J., C11.
AMERICAN ASSOCIATION OF TEXTILE CHEMISTS AND COLORISTS, D195.
AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS, D196.
AMERICAN SOCIETY OF CHEMICAL ENGINEERS, D20.
ANDERSON, H. V., A3, A27.
ANSCHÜTZ, R., F36.
ARENDT, M., D249.
ARRHENIUS, S., C180.
ASHTON, F. W., C5.
AUDRIETH, L. F., C1.
AUDUBERT, R., C68.

BABOR, J. A., C43, C124.
BADGER, W. L., D142.
BAILEY, D., K23.
BAILEY, K. C., K23.
BAKER, E. M., D142.
BARNESS, H. T., D126.
BARRETT, O. W., D276.
BARRETT, W. H., C33.
BECK, D. W., C121.
BEHRE, A., D54.
BELCHER, J. E., A8.
BELL, J. M., C161.
BEROLZHEIMER, D. D., H1.
BIEDERMANN, R., K11.
BLASDALE, W. C., A35.
BLOCK, W., C142.
BLOSE, D. T., I21.
BLUMENTHAL, F. H., D183.
BOBRANSKI, B., A18.
BOGUE, R. H., C5.
BOND, N. G., I31.
BOSNJAKOVIC, F., D81.
BRADY, G. S., D172.
BRANFOOT, M. H., B28.
BRASS, K., D204.
BRAY, J. L., D206.
BREWER, J. M., I5.
BRODERICK, J. T., G9.
BROWN, B. K., D255.
BROWN, H. E., I23.
BUCHANAN, R. E., B3.
BUGGE, G., G3.
BUTLER, J. A. V., C191.
BUTTS, A., D181.

CAMERON, A. T., B5.
CARNEGIE INSTITUTE OF TECHNOLOGY, D210.
CARRÉ, M. H., B28.
CARTLEDGE, G. H., C48.
CAVEN, R. M., C40.
CHAMBERLAIN, D. S., A27.
CHAMBERLAIN, J. S., F40.
CHEMICAL CATALOG CO., D48.
CHIMIE ET INDUSTRIE, G8.
CLARK, A. H., F27.
CLARK, C. L., D240.
CLARK, W., D211.
CLARK, W. M., C79.
CLARKE, H. T., F29.
CLAYTON, W., C90.
CLEMENTS, F., D33.
COCHRANE CORPORATION, D105.
COLBERT, J. C., A8.
COLES, L. A., F14.
COLLIER, F. W., E21.
COLWELL, N. P., I40.
COMMITTEE ON RECENT ECONOMIC CHANGES OF THE PRESIDENT'S UNEMPLOYMENT CONFERENCE, K49.
CONANT, J. B., F25, F30.
CONSTABLE, F. H., F6.
CORNOG, J., A29.
CRANE, E. J., K32.
CRANSTON, J. A., C40.
CRAWFORD, A. B., I32.
CRAWFORD, M., D255.
CREIGHTON, H. J., D205.
CRENNELL, J. T., D5.
CROCKER, J. C., C162.
CROWTHER, J. A., J2.
CULVER, G. E., F24.
CURTIS, C. A., D149.

DANCKWORTT, P. W., A10, A11.
DAVIDSOHN, J., D156.
DEBYE, P., C149.
DEPARTMENT OF COMMERCE, D9.
DEPARTMENT OF THE INTERIOR, H2–3 I4, I10–12, I16–17, I20–21, I28, I34, I48.
DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH, D222.
DESBLEDS, L. B., D98.
DESCROIX, L., D21.
DEUTSCHE FÄRBER ZEITUNG, D80.
DREWS, K., D259.
DRUCKER, C., C86.
DUBRISAY, R., C58.
DUFTON, A. F., D124.
DUNN, M. S., C94.

EHLERS, C., D228.
EITEL, W., C163.
ENGINEERING DEPARTMENT, THE SURFACE COMBUSTION CO., D77.
ENGINEERING FOUNDATION, THE, G16.
ERBACHER, O., C9.
ERRERA, J., J14.
EUCKEN, A., C164.
EVANS, H. R., I22.
EVANS, W. L., C123.
EYNON, L., D242.

FARADAY SOCIETY, C26, C28.
FARNSWORTH, M., A36.
FISCHER, F., F13.
FISCHER, W., D15.
FISHENDEN, M., D124.
FLOYD, L. P., C44.
FOSTER, W., C47.
FOTH, G., D120.
FOWLER, R. H., J6.
FRANCE, W. G., C127.
FRICK, H. C., I60, I61.
FRIEND, K. N., C36.
FROST, W., A24.
FRY, T. C., D208.
FUCHS, F. J., C138.
FÜRTH, A, D286.
FULMER, E. I., B3.
FURMAN, N. H., A40, A41.
FURNESS I. W., D183.

GEBER, E34.
GERLACH, W., C138.
GESELLSCHAFT FÜR LINDE'S EISMASCHINEN, A.-G., E13.
GIBBS, J. W., C59.
GLASSTONE, S., G6.
GODDARD, A. E., C36.
GODDARD, D., C36.
GORDON, N. E., C37.
GRADWOHL, I. E., B10.
GRADWOHL, R. B. A., B10.
GRAFFIGNY, H. DE, D40.
GRAY, C. W., C41.
GREENLEAF, W. J., I10, I34.
GREY, E. C., A17.
GRIFFITH, I., G17.
GRIFFITHS, E., D123.
GROSS, P. M., C161.
GROSSMANN, H., G15.
GUDDEN, B., J11.

HAAS, P., B14, B15.
HACKH, I. W. D., C31, K22.
HAHN, F. V. VON, C80.
HALL, W. T., A34.
HAMILTON, T. S., B2.
HAMMETT, L. P., A33.
HARROW, B., E11.
HARTLEY, L. A., D87.
HATSCHEK, E., C135.
HAWORTH, W. N., F7.
HEATON, L., H5.
HELLER, H., D277.
HENDERSON, W. E., C123.
HERMANN, C., D106.
HESSE, A., B20.
HEYVOVSKÝ, J., K16.
HIGGIN, E18.
HILDEBRAND, J. H., C52.
HILDITCH, T. P., D43.
HILL, A. V., B1.
HILL, T. G., B14, B15.
HILLEBRAND, W. F., A9.
HOCART, R., C167.
HODGMAN, C. D., K33.
HOLLAND, M., G11.
HOLMYARD, E. V., E34.
HOLWAY, H., G20.
HOSTMANN, J., B13.
HOUBEN, J., D15.
HÜCKEL, E., C4.
HULL, C., I24, I25.
HURD, C. D., F34.

INCORPORATED ASSOCIATION OF HEAD MASTERS OF PUBLIC SCHOOLS AND THE MINISTRY OF LABOR, I8.
INSTITUTION OF CHEMICAL ENGINEERS, THE, D274.
INSTITUTION OF PETROLEUM TECHNOLOGISTS, THE, D241.

JACOB, J., A7.
JELLINEK, K., C165.
JESSEN, C. A., I28.
JOFFE, A. F., J1.
JOHNSON, J. R., F17.
JONES, L. M., D183.
JORDAN, C. B., A12.

KAUSCH, O., C175.
KEESECHER, W. W., I16.
KEFFER, R., D181.
KEHRMANN, F., F12.
KENDALL, E. C., B34.
KENDALL, J., C53, C126, G1.
KIMBALL, D. S., D134.
KIRSCH, G., K30.
KLEIN, A. J., I30.
KLEINMANN, H., A20.
KOETSCHAU, R., D85.
KOLTHOFF, I. M., A40, A41.

KOPACZEWSKI, W., D96.
KOPPEL, I., K11.
KRÖHNKE, O., C121.
KUNBERGER, A. F., D111.

LANE, J. H., D242.
LANGE, E., C85.
LANGE, N. A., K33.
LANGE, O., C89.
LAQUER, F., B24.
LASSAR-COHN, F29.
LATIMER, W. M., C52.
LAWRIE, J. W., D115.
LEA, F. M., D5.
LEHNE, A., D267, D268.
LEHRMANN, A., C124.
LERCH, W., C5.
LIESCHE, O., K12.
LISTER, W., D203.
LITTLE, A. D., G10.
LOEB, L. B., J1.
LONG, J. S., A3, A27.
LONGLEY, W. R., C59.
LORENZ, R., C102.
LÖWE, F., C13.
LOWELL, A. L., I19.
LUNDELL, G. E. F., A9.
LUNN, B., E23.
LUNN, BEATRIX, E23.
LUTTRINGER, A. D., D41.
LYMAN, T., J15.

MAASS, E., C121.
MACEDO SOARES, J. C. DE, D39..
MACK, E., JR., C127.
MACLEAN, J., C73.
MACLEOD, A. L., C57.
MAILHE, A., D68.
MANTELL, C. L., D129, D272.
MANUFACTURERS' RECORD, K4.
MARSH, J. E., E25.
MASTERS, W. M., C44.
MATTHEWS, F., C162.
MATULA, J., C32.
MAYER, A. W., K13.
MCDONALD, P. M., K25.
MCELVAIN, S. M., F8.
MCNEIL, C. L., D181.
MCPHERSON, W., C123.
MEADE, R. K., K14.
MECKE, R., C17.
MEERBOTT, P. B., D11.
MEISSNER, K. D., J10.
MEISTER, M., J3.
MELHARDT, H., D279.
MELLON, M. G., K10.
MELLON INSTITUTE OF INDUSTRIAL RESEARCH, G18.
MELLOR, J. W., C35.
MENZEL, H., A40, A41.
MERKEL, F., D81.
MEYER, R. J., C7, C8.
MILLER, H. K., A31.
MITCHELL, C. A., A2.
MITCHELL, H. H., B2.
MOREHART, G. C., I42.
MOULTON, C. R., D174.
MÜLLER, W. J., I77.
MUHLERT, F., D259.

NAKASEKO, R., E3, E4.
NAOUM, P., D186.
NEWCOMB, E. L., K37.
NEWELL, L. C., C21.
NEWMAN, F. H., J5.
NORD, F. F., B12.
NORTON OF BRISTOLL, T., E1.

OAKES, M. E., I23.
ODELL, C. W., H4, I3, I13, I51.
OEMAN, E., D169.
OESPER, R. E., F29.
OPPENHEIMER, C., C32, F23.
OSANN, B., D158.
OSEEN, C. W., C6.

PALMAER, W., C77.
PANETH, F., C88.
PARINGTON, J. R., K5.
PATTERSON, A. M., K32.
PERRY, A., I18.
PFEIFFER, H., B19.
PHILLIPS, F. M., I2, I11, I45.
PIERRON, L., D209.
PITKIN, W. B., K3.
PLOTNIKOW, J., C157.
PORTER, C. W., C146.
PRICE, T. S., D211.
PRIESTLEY, J., C73.
PRINGLE, H. F., G11.
PROCHAZKA, G. A. JR., D1.
PROFFITT, M. M., I12.
PULVERMACHER, W. D., I26.

QUINTIN, M., C68.

RAWLINS, F. I. G., C113.
REED, E. L., D199.
REGNAULD, M., D179.
REINDEL, F., F36.
REINTHALER, F., D24.
REMFRY, J., D215.
REYNOLDS, W. C., C14.
RICHARDSON, L. B., C125.
RICHTMEYER, F. K., J7.
RIEGEL, E. R., D132.
RIGG, G., D227.
ROBERTS, J. K., J4.
ROEMER, J., I64.
ROGERS, T. A., F24.
ROMMEL, G. M., D102.
ROTH, W. A., K11.
ROWE, F. M., D24.
RUSSELL, R., E34.

SADTLER, S. P., B13.
SÄNDIG, K., D148.
SCARLETT, A. J. JR., C125.
SCHEIBER, J., D148.
SCHMIDT, J., F16.
SCHMIDT, W., D169.
SCHNEIDEWIND, R., D250.
SCHÜCK, H., E23.
SCOTT, W. W., A28.
SEARLE, V. H. L., J5.
SIEMENS UND HALSKE, A.-G., D287.
SINGER, L., K2.
SMITH, D. P., A31.
SMITHELLS, C. J., D128.
SOARES, J. C. DE MACEDO, D39.
SOCIETY OF CHEMICAL INDUSTRY, D13.
SOHLMAN, R., E23.
STANISLAUS, I. V. S., D11.
STARK, J., C16.
STAUDINGER, H., A24.
STEPHENSON, I. N., D166, D167.
STIEGLITZ, J., G7.
STONE, H. W., C94.
STORE, B. V., D211.
STREBEL, R. F., I42.
STROUP, F. P., B13.
SUCHARDA, E., A18.
SUHRMANN, R., C164.
SURFACE COMBUSTION COMPANY, D77.
SUTERMEISTER, E., D60.

SVEDBERG, T., C38.
SWANSON, C. O., B18.
SYMMES, E. M., D186.

TANNER, F. W., B4.
TAPSELL, H. J., D215.
TAYLOR, A. M., C113.
TAYLOR, F. S., C160.
TAYLOR, W. A., C111.
TECHNOLOGY PRESS, THE, I1.
TEEPLE, J. E., D133.
THOM, W. T. JR., D195.
THOMSON, G. P., C75.
THOMSON, J. J., C75.
TIGERT, J. J., I4.
TRAVERS, M. W., E9.
TRAVIS, P. M., C69.
TREADWELL, F. P., A34.
TWEEDY, S. K., K5.

UBBELOHDE, L., D277.
ULLMANN, F., K27, K28.
UNIVERSITY OF WASHINGTON, I6.

VAIL, J. G., D236.
VAN NAME, R. G., C59.
VAN'T HOFF, J. H., C180.
VEDDER, E. B., G5.
VEREIN DEUTSCHER CHEMIKER, D147, D280.
VERNON, W. H. J., H8.
VILLAVECCHIA, G. V., K24.
VOORHEES, E. B., D104.
VOSBURGH, C. H., I26.
VOSBURGH, W. C., A29.
VOTOČEK, E., K16.

WAGNER, A., F37.
WAGNER, R., D30.
WALDEN, P., C1.
WALDSCHMIDT-LEITZ, E., B22.
WALL, E. J., D197.
WALLER, P., K21.
WALTON, D. C., G5.
WALTON, R. P., B22.
WARSER, B., D31.
WASHBURN, E. W., C148, K18, K19.
WATKINS, G. S., D152.
WEICHHERZ, J., D164.
WEISER, H. B., C65, C71.
WELLS, H. G., D47.
WEST, C. J., D14, D219, H1, H9, I24, I25.

WHITE, A. E., D240.
WILEY, H. W., B17.
WILKINSON, J. A., A4.
WILSON, J. A., D59.
WOHRYZEK, O., D53.
WOLCOTT, J. D., H2, H3, I48.
WOODRING, M. N., I23.
WOOLRICH, W. R., D117.
WORDEN, E. C., D51.

YALE UNIVERSITY, I9.
YOE, J. H., A20.

ZANDER, H. H., D285.

G. N. Lewis Receives One of Royal Society Medals. The Royal Society's highest honor in chemistry, the Davy medal, will be conferred upon Prof. G. N. Lewis, of the University of California, for his contributions to classical thermodynamics and the theory of chemical valence. Prof. Lewis is a pioneer in the study of atom structure and his researches have allowed chemists to know more precisely what happens when substances come together. The Davy medal was founded by the brother of the famous Sir Humphry Davy and is given annually for the most important discovery in chemistry in Europe, the United States, or Canada.

Prof. Max Planck, of the University of Berlin, famed as the originator of the quantum theory, has been awarded the Copley medal of the Royal Society for his contributions to theoretical physics.

Another German, Prof. Hans Geiger of Kiel University, whose atom counter is being used in laboratories all over the world, was given the Hughes medal by the Royal Society for the development of methods of counting alpha and beta particles.

The two Royal medals, which have been awarded annually since their establishment by George IV, were awarded Prof. J. E. Littlewood, of Cambridge, for his work on mathematical analysis and Prof. Robert Muir, Glasgow immunologist, for his medical work.—*Science Service*

Irradiating Chocolate Now Being Tested. A way to irradiate chocolate so that its flavor is not impaired has been discovered by two Austrian scientists, Drs. S. Reid and H. Krasso. Rats fed on this chocolate gained in weight. Patients enjoyed it and showed improvement in appetite and general condition and a gain in weight. The chocolate was fed as milk chocolate and as a beverage made with milk.

Most of the patients to whom this chocolate was given were suffering from tuberculosis. A few suffering from secondary anemia showed improvement in the condition of their blood. Dr. Krasso also suggests that irradiated chocolate might prove valuable in the treatment of disease of the bones, such as rickets.—*Science Service*

Find Lead Poisoning in Brass and Bronze Industries. Lead poisoning as an occupational disease of the brass and bronze industries was discussed at the recent Minneapolis meeting of the American Public Health Association.

Of 38 men engaged in the founding of high-lead bronze who were sent to the Montreal General Hospital for various complaints, 24 were found to be suffering from acute lead poisoning, 9 others showed different evidence of lead absorption and only 5 showed no signs of lead poisoning, Drs. Frank G. Pedley and R. V. Ward of Montreal reported.

"It is our belief that lead plays an important part in the disease picture variously diagnosed as brass poisoning, bronze poisoning, and copper poisoning," the Canadian scientists stated.

Examination of men engaged in polishing low-lead brass and bronze, and a review of the literature, showed many cases of chronic disability, in which the symptoms are much like those of lead poisoning.—*Science Service*